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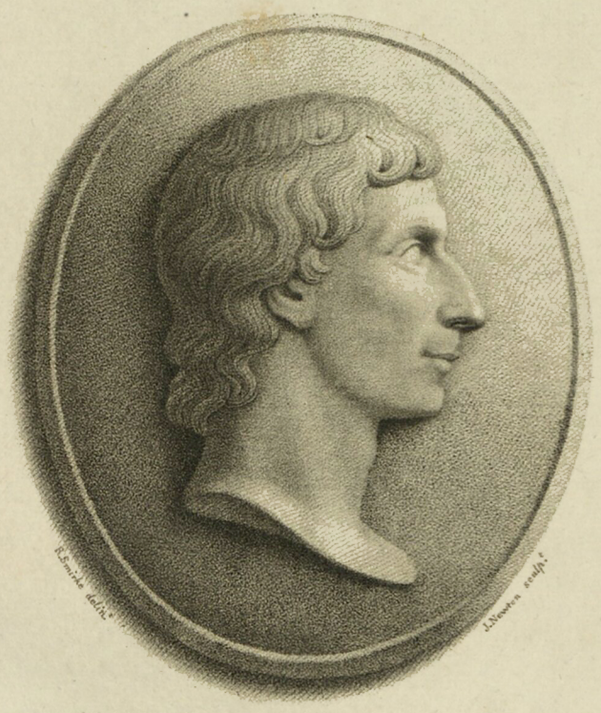

WILLIAM NEWTON, ARCH.T

Gab.l Manigault.
1802

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO:

TRANSLATED

FROM THE ORIGINAL LATIN,

BY

W. NEWTON, ARCHITECT.

VOLUME THE FIRST.

LONDON:

PRINTED FOR JAMES NEWTON, 32, THORNHAUGH STREET, BEDFORD SQUARE; AND SOLD BY I. AND J. TAYLOR, HOLBORN; R. FAULDER, NEW BOND STREET; P. ELMSLY, STRAND; AND T. SEWELL, CORNHILL.

M.DCC.XCI.

TO THE PUBLIC.

As the appearance of theſe Volumes, after the deceaſe of their Author, may poſſibly occaſion, in the minds of ſome perſons, an idea that part of their contents is not the genuine performance of my Brother, the late Mr. William Newton, it will be proper in this place to inform the Public, that the Letter-Preſs of the Firſt Volume, and of a great part of the Second, was printed before his death; and, ſince that period, the remaining part has been carefully printed from a correct manuſcript copy prepared by himſelf; and which, conformable to his Will, came into my poſſeſſion, with his expreſs orders for completing and publiſhing the Work. The Plates were likewiſe chiefly finiſhed before his deceaſe; thoſe which have been ſince engraved, were copied from his own highly finiſhed Deſigns; and the Portrait was engraved from a Drawing taken only a few weeks previous to that unfortunate event. The Work, in this very advanced ſtate, came into my poſſeſſion; and the part which devolved upon me having been executed with a ſtrict regard to his inſtructions, I hope I ſhall be juſtified in aſſerting, that the whole Work, as here preſented to the Public, is preciſely what its Author intended.

Thornhaugh Street,
Bedford Square.

JAMES NEWTON.

TO THE KING.

May it pleaſe your Majeſty,

TO permit me to preſent you with the firſt Engliſh tranſlation of the Architecture of M. Vitruvius Pollio, inſcribed by the author to the great Auguſtus, or perhaps, with greater probability, to the benevolent Titus. The works of this writer have ever been judged worthy of the patronage and attention of the ſovereigns of thoſe countries in which they have reſpectively been publiſhed. The public having favourably received my former endeavours on this ſubject, I now preſume to ſolicit that protection which works only of approved merit can deſerve.

The whole being now complete, I am encouraged to preſent it to your Majeſty, as the patron and judge of the art which is here taught and exemplified.

The great advances which this, as well as other ſciences, have made during your Majeſty's reign, ſtrongly prove the encouragement they have received. I ſhall have attained the utmoſt reward of my labours, ſhould they in any degree contribute to the promoting your Majeſty's intentions, or tend to the uſe and advantage of my country.

I remain

Your Majeſty's obedient Servant,

And dutiful Subject,

WILLIAM NEWTON.

PREFACE.

WHILE all the polished nations of Europe possess a Translation of the Architecture of M. Vitruvius Pollio, whereby their architects have the opportunity of perusing, in their own language, the father of their art, Great Britain, and its extensive dominions, remain without that advantage; and the British architects (for the major part) without the knowledge of the most ancient writer on the subject whose labours have reached our times.

THE nations around us having been all long since thus provided, it may seem to cast some reflection on our taste and talents for the fine arts, that we have so long neglected this distinguished author. The art he teaches is one of the most useful, elegant, manly, and comprehensive, in which the strongest intellects and most fertile fancy may have scope to move, and the efforts of the judgment and genius may be shewn united.

BUT our neglect of the arts hitherto, and the little figure we have made therein, may probably be owing to our intestine commotions, and the unsettled state of the nation for many years past. The arts could not be regarded, while objects more essential to the public good were struggling, and in hazard. Italy long enjoyed a profound tranquillity; there therefore the arts revived and flourished, but now seem to be retiring. We may observe also that the course of the arts, as well as of empire, has been directed westward; and they may not yet have arrived at the full zenith of our isle. They however now appear to be advancing apace, and there is a prospect that they will reach their utmost height and perfection in this nation.

LONG before I entertained any thoughts of this undertaking, I had frequently occasion to observe the want of an English translation. To have recourse to the text, on all occasions, is not sufficiently expeditious in business for those who are not exceedingly well versed in the Latin, nor indeed for those who have not particularly studied the style and terms of this author. It is true that the majority of those who have wrote on architecture have drawn the principles they inculcate from the text of Vitruvius, and their writings are in a great measure transcripts of his; they, nevertheless, do not answer the end of a translation: the precepts of Vitruvius are often promiscuously blended with their own ideas, or interpreted in such a manner as to serve a particular purpose; by which means the sense of the original is perverted or misrepresented.

PERAULT, in the preface of his French translation, attributes the difficulty of translating this author to the necessary qualifications for such a performance rarely meeting in one person. An architect, bred chiefly to the knowledge of his profession, is seldom sufficiently skilled in language, and several other requisite sciences; and very few men of literature have a knowledge of architecture, and a genius for the fine arts, sufficient to enable them to undertake the task; the turn of mind adapted to the one seeming unsuited to the other kind of studies: we may add likewise, that, in those who may be sufficiently qualified, the inclination and opportunity to exert their abilities in such a work do not always concur. To wait, therefore, till all these requisites unite, might be endless; and it may be preferable to

avail ourſelves of an inferior performance, in ſome degree uſeful, than to be wholly without the knowledge of this author. Theſe reaſons, and ſeeing it neglected by others, have induced me to attempt this arduous undertaking; not vainly preſuming on abilities equal to the taſk, but hoping that in the knowledge of the principal ſubject, and in ſome degree at leaſt of the ſeveral neceſſary qualifications, I may not be found deficient.

THE eſteem in which the writings of this author have ever been held, is apparent from the number of manuſcripts, printed editions, and tranſlations into all the European languages which have been made thereof. The fifteenth century, the time when the fine arts began to revive, gave birth to many printed editions, comments, and tranſlations of this author, in ſundry parts of Europe: of theſe it is proper to give ſome account.

THE firſt printed edition of the text was that of Sulpitius, which appeared about the year 1486. *In* 1496, *one was printed at Florence; and in* 1497, *another at Venice. In* 1511, *Jocundus publiſhed a new edition at Venice, which he reprinted, with corrections, at Florence, in* 1513, 1522, *and* 1523. *In* 1521, *the firſt tranſlation was made in Italian, by Cæſar Ceſariani, and publiſhed at Como, in the Milaneſe. Another Italian tranſlation was publiſhed by Lucio Durantino, at Venice, in* 1524, *and again in* 1535. *In* 1536, *an Italian tranſlation of the firſt five books, by Giovanni Baptiſta Caporali, was publiſhed in Peruſia.*

IN 1542, *A Compendium of the Writings of Vitruvius, in the Spaniſh tongue, was publiſhed at Madrid, by Don Didaco Sagredi, which was reprinted at Toledo, in* 1549 *and* 1564. *A new Latin edition was printed at Straſburgh, in* 1543, *and again in* 1550.

IN 1544, *Philander publiſhed his Latin Annotations on the ten Books of the Architecture of Vitruvius, incited thereto by Francis the Firſt, ſtyled The Reſtorer of the Liberal Arts; but, in theſe annotations, more regard is ſhewn to literary punctilios, and the etymology of the Greek and Latin terms, than to the illuſtration of the architectonical matters.*

IN 1547, *the year Francis the Firſt died, the firſt French tranſlation appeared, executed by Jean Martin, ſecretary to the Cardinal de Lenoncour, with the aſſiſtance of J. Goujon, architect to the kings Francis the Firſt and Henry the Second: this was dedicated to the latter of the two kings, though that compliment was evidently intended to the former, had not his death prevented it. This tranſlation, which was made by a man of letters, who had not a competent knowledge of architecture, is found to have very little merit; it was, however, reprinted in* 1572, *and again at Cologne in* 1618.

IN 1548, *a German tranſlation, with notes, was publiſhed at Nuremburgh, by Gualter Rivius; which was republiſhed at Baſil, in Switzerland, in* 1575 *and in* 1614. *This tranſlation is commended by Sir Henry Wotton, in his Elements of Architecture.*

IN 1552, *Philander publiſhed, at Lions, a Latin edition of Vitruvius, with annotations; and again in* 1586 *at Geneva.*

IN 1556, *the learned Daniel Barbaro, patriarch of Aquileia, publiſhed an Italian tranſlation of Vitruvius at Venice, with draughts and copious annotations; in which it is probable he had the aſſiſtance of that celebrated and ennobled architect Andrea Palladio; their draughts, as well as their explanations of ſundry paſſages of the text, exactly correſponding. This tranſlation was again publiſhed in* 1567, *accompanied with a new edition of the text, and comments by the ſame hand; and the tranſlation was again publiſhed at Venice, in* 1629.

AN Italian tranſlation was intended by Giovanni Antonio Ruſconi, but his death prevented its appearance: the draughts he left were, however, collected by Giolito, and publiſhed at Venice in 1590, *with ſhort explanations annexed. Many manuſcript tranſlations are ſaid to be diſperſed about Italy, which were never printed; one is now*

preſerved in the Vatican library, at Rome; and another in the Corſini library, believed to have been made by Sangallo.

IN 1649, *a valuable edition of the text, with comments extracted from Philander, Barbaro, Salmaſius, and other commentators, was publiſhed at Amſterdam, by J. de Laet, and dedicated to Chriſtina, Queen of Sweden; to this was annexed, The Elements of Architecture, wrote by our countryman Sir Henry Wotton, and The Comments of Marcus Meibonius on Vitruvius; the Diſſertation of Nicholas Goldmanuo on the Ionic Volute; and the Lexicon of Bernardino Baldus, explaining the unuſual words and technical terms made uſe of by Vitruvius; together with his Treatiſe on the Scamilli Impares, mentioned in the third chapter of the third book.*

AFTER this comes the pompous French tranſlation, executed by the learned Claude Perault, phyſician and architect, at the command and expence of Lewis the Fourteenth, enriched with numerous comments and elegant engravings. This was publiſhed in 1673, *and indeed much excelled all the preceding tranſlations: it was again publiſhed, with corrections, in* 1684.

SINCE this, divers men of erudition and ingenuity have wrote comments on the writings of Vitruvius, particularly the Marquis Poleni, in his treatiſe ſtyled Exercitationes Vitruvianæ, publiſhed in 1739 *and* 1741. *An edition of the text has been long expected from the ſame hand, but has never yet appeared.*

OUR countryman, John Evelyn, Eſq. F.R.S. muſt not be wholly omitted. He has given ſome pertinent remarks on the terms of Vitruvius, in his tranſlation of the Parallel of the Ancient Architecture with the Modern, which he publiſhed in 1664, *and dedicated to Charles the Second.*

ROBERT Caſtel, in his Villas of the Ancients, which he publiſhed in 1728, *and dedicated to Richard Earl of Burlington, profeſſes that he undertook that treatiſe as a preparative to a tranſlation of Vitruvius into the Engliſh language; a work he had long entertained a deſire of performing. This intention of Robert Caſtel was mentioned in the Acta Erudit. Lipſiæ,* 1731: *he, however, never fulfilled his promiſe; and it is probable that his immature death prevented his deſign.*

LASTLY, in 1758 *appeared, at Naples, an edition of the text, joined with an Italian tranſlation, dedicated to the King of Naples, by the Marquis Berardo Galiani; this performance has eclipſed all the preceding. The Marquis has made ſeveral new and uſeful illuſtrations; he very ſtrictly adheres to the text; and his comments are judicious, and chiefly relative to the principal ſubject, architecture, which moſt of the former commentators have too much neglected. To the labours of this author I muſt acknowledge myſelf much indebted; they have been of conſiderable ſervice to me in the courſe of this undertaking, although our ſentiments have not in every circumſtance coincided.*

IT is now neceſſary to ſpeak of this tranſlation, and to give ſome account of the methods purſued in the conduct thereof, in order to render it more intelligible to the reader.

I HAVE made uſe of the printed editions of Barbaro, De Laet, and Galiani; and, when occaſion required, of ſundry manuſcripts. I have in no place, as I recollect, taken the liberty to alter or depart from the text; but, if any difficulty or ambiguity has occurred, have remarked it in the notes, and given the opinions of the commentators, or my own thoughts, thereon. Many reaſons concurred to induce me to be as literal in the tranſlation as poſſible: this has often occaſioned me to run into the Latin idiom; which, although it may read leſs fluently, will not be leſs intelligible; and, by

conveying the meaning more exactly, may be in some respects more useful. The numerous ambiguities, the peculiar style, and use of the technical terms, made it impossible to be avoided without much circumlocution, or the hazard of perverting the sense of the author; and this, those who are best acquainted with the uncertainty and perplexity of the text in many parts, will not, I believe, be the most forward to censure.

IN order to avoid a multiplicity of words and explanations, I have made use of letters of reference, which are placed next to the word referred from: such of these as are not in the text, and have not been used by Vitruvius himself, are inclosed in parentheses; and wherever it has been necessary, for the sake of rendering the passage more intelligible, to add a word that is not drawn from the context, it is usually inclosed in a parenthesis.

THE modern technical terms being very indeterminate and uncertain, differing in different times, places, and persons; and, in our own language, being almost wholly borrowed from the Italian or French, I have thought it most advisable to adhere to the Latin terms entirely, and to explain them where necessary in the notes; the reader will, therefore, find the explanation of any unknown term at that place where it is first mentioned, as well as at other places, by the letters of reference and figures.

IN making the draughts, I have followed the order in which they are described by Vitruvius, numbering them from the first onward, so that they may be bound at the end of the several books to which they respectively relate, in the manner they were disposed by Vitruvius himself; or altogether, at the end of the whole; or each opposite to the page wherein it is described.

THE draughts which Vitruvius himself made, and annexed to his book, are all lost; so that his commentators have been obliged to compose them anew from his descriptions. In doing this, as well as in investigating the sense of the obscure passages of the text, I made it a rule to collect my own ideas on the subject, before I allowed myself to learn those of others; after which, I examined and consulted all others I could meet with; and from the whole, with as much impartiality as I could master, selected that which I judged the most consistent, and most conformable to the intention of the author. To this method, the several corrections and new illustrations, which I think will be found in the ensuing work, are chiefly owing: the previous knowledge of the ideas of others so influences the mind, that it becomes almost impossible, or at least very difficult, to think in any other track.

IN the comments, I have chiefly attended to the explanation of the architecture, and of matters relative thereto; leaving other subjects, as being out of my province, to be discussed by those who are more concerned in such studies.

THE division into chapters is not used in any of the manuscripts I have met with, and was probably not done by Vitruvius, the ancients not using that mode of dividing their writings: it is said to be found in some manuscripts, having been done, as it is supposed, by the copyists; and is used in all the printed editions. I have therefore thought proper to retain it in this translation; as, by dividing and distinguishing the several subjects, it facilitates the discovery of any part of the discourse, and helps the memory.

I HAVE had now and then occasion to give my own opinion. This, I believe, I have generally done without accompanying it with any of the usual terms of diffidence or humility; they are omitted to avoid unnecessary affectation, and for the sake of brevity: the reader is therefore requested not to impute that omission to confidence or self-conceit. I wish it to be understood that I speak my sentiments with that diffidence that becomes every man. I have endeavoured to be in the right; but, if I have failed, I shall with pleasure see my errors corrected. My aim is truth; and, by whomsoever it is found, it is to me equally welcome and acceptable.

IN perusing the following treatise, the reader will meet with several passages that will occasion him to reflect on the difference between Vitruvius's manner of teaching the art and that made use of by modern masters; the former directs us to vary the proportions and dispositions of the members according to the magnitude, situation, purpose, and other circumstances of the building; the latter offer no rules of that kind, but prescribe a certain fixed modulation of the parts of each order, to be used in all edifices, however circumstanced: each author recommending such as his peculiar studies, or some other accidents, have occasioned to make a favourable impression on his mind. But I see no reason for such a partial attachment to any certain manner, nor merit in such indiscriminate application of it; it appears more like mechanism than intelligence: the weakest understanding and poorest genius may be capable of attaining such a habit. It is, indeed, the general fate of artists to be manneriſts; but it is not on that account less erroneous, nor ought it to be less opposed.

I imagine that every building should by its appearance express its destination and purpose; and that some character should prevail therein which is suitable to, and expressive of, the particular end it is to answer. To effect this, will require the exertion of the powers of the mind, the fire of genius, and the solidity of judgment; and, without this, a composition is but a compilation of parts, without meaning or end.

ARCHITECTURE may be distinguished into the essential and the ornamental parts: the first regards the real qualities of buildings, their convenience, strength, &c.; the other has relation only to their outward appearance, or effect. In the former respect, architecture ranks with those arts which relate to the necessaries and conveniencies of life; in the latter, with the arts of entertainment, painting, poetry, and music, called the liberal arts.[1*]

SOME may object that, as the end of all compositions in the liberal arts is to entertain, provided they appear pleasing, it is sufficient, without regarding whether that appearance is suitable and adapted to the circumstances of the work. It is true that such an appearance will be sufficient to please the fancy, but not to satisfy the judgment. Works of art should please by their propriety as well as beauty; and a pleasing appearance, that is suitable to the work, must certainly be preferable to one that is unsuitable: the gaiety and lightness of a villa may be equally pleasing if applied to a prison or a castle; but no one can affirm that they will be equally proper and well adapted. Beauty will, by repetition and continuance, lose its effect; but propriety will maintain and produce its effect for ever. It may be added, also, that works of art may be directed to the elevation and improvement of the mind, as well as to its entertainment only, by exciting worthy or generous sentiments; and that this, perhaps, should be considered as their ultimate end, to which the pleasure they afford is only the attractive means.

IT appears, therefore, that the first care of an architect, when he is about to design any building, should be, to consider the full destination and purpose of the edifice, from thence to determine the character which is proper and suitable thereto, and then to compose the building in such a manner as to be expressive of such character. I am now speaking only of the appearance and ornamental part of buildings; not of their convenience, strength, or other essential qualities, which are understood to be always first regarded.

THE appearance of any character in an object, I suppose to be the result of the particular modification of its component parts, and the aptness and allusion of the ornaments. To modify an object, is to vary or graduate its sensible properties. In architecture, and other arts respecting the sight, such properties only as are visible are to be attended to, viz. all that relate to figure and colour; and, in other arts, such properties as relate to the senses to which those arts respectively belong.

(1*) *Architecture, as well as sculpture, is included by the word* painting, *which, in this case, is understood to signify all those arts of entertainment whose effects are perceived by the sense of seeing, as* music *and* poetry *do those which relate to the hearing and understanding.*

THE deſtination of a building is diviſible into three heads; as, for example, the uſe it is to ſerve, the place in which it is to be ſituated, and the perſon for whoſe uſe it is intended: each ſhould be conſidered in determining the character ſuitable to the building.

THE characters or effects which there may be occaſion to expreſs in buildings, may be diſtinguiſhed into the pleaſing and the elevating, or thoſe of beauty and dignity. The ſeveral characters of either claſs might be aſcertained, as well as the kinds and degrees of the ſenſible properties that will produce the appearance of each character: but it would carry me farther than I intend in this preface; in which I only mean to give a general ſketch of my ſentiments on this matter, in order to ſhew the opening there ſeems to be for a full diſquiſition of the ſubject, and the poſſibility of bringing the art of deſigning in architecture (which, at preſent, has no guide but fancy or habit) to ſome regulation and certainty.

OBSERVATIONS

CONCERNING THE

LIFE OF VITRUVIUS.

WE know little more concerning Vitruvius than what is to be gathered from his own writings. From theſe we learn, that his parents cauſed him to be early inſtructed in architecture, as well as in many other ſciences. We have no account of his parents, or the place of his birth: but he was doubtleſsly a native of ſome part of Italy, if not of Rome itſelf; for, in ſundry parts of his book, he uſes the words *nos*, *noſter*, &c. to diſtinguiſh the Romans, and their buildings, from all others. By the knowledge he appears to have had of divers nations, and their public edifices, it is very probable that he had ſpent much of his time in travel. He tells us he had acquired ſome fortune, as well as reputation, by his profeſſion; but, in his ſixth proem, he ſays, it was not to be wondered at that he was ſo little known; for he had not, like the generality of architects, been forward in ſoliciting and petitioning for employment, having learnt not to be ſolicitous of care, and being aſhamed to requeſt advantages.

He was one of the engineers of the Roman army; civil and military architecture being at that time united and practiſed as one profeſſion. From his own words, in his ſecond preface, we learn that he was low of ſtature, and was old and infirm when he publiſhed his writings. The period in which he wrote, and the emperor to whom he dedicated his books, are points not yet aſcertained; ſome arguing for the time of Auguſtus, and others for that of one of the ſucceeding emperors, particularly Titus. The former opinion is, however, the moſt generally received; notwithſtanding which, ſeveral circumſtances that I have obſerved oblige me to incline to the latter. I will, therefore, here mention the principal arguments on both ſides, that the reader may be able to judge for himſelf.

The arguments for the reign of Auguſtus are,

1ſt, That though Vitruvius, in the courſe of his work, makes mention of many remarkable public edifices that were erected before the reign of Auguſtus, he yet mentions none of thoſe magnificent ſtructures that were erected during or after that time; which it is probable he would not have omitted, had he wrote after that period.

2dly, That Vitruvius does not treat of amphitheatres, which were common in the time of Titus, although ſcarcely known in that of Auguſtus; and it is to be ſuppoſed that he would not have omitted treating of ſuch large, elegant, and ſingular buildings, if they had been common at the time he lived.

3dly, That Vitruvius (Book III. Chap. II.) mentions *The Stone Theatre*, ſpeaking in the ſingular number, which implies that there was but one ſtone theatre in his time (*viz.* Pompey's theatre); and as there was but that one in the beginning of Auguſtus's reign, and as ſeveral were erected during that and the two or three following reigns, it is probable that Vitruvius wrote at a time when there was only that ſingle ſtone theatre ſubſiſting, and conſequently in the time of Auguſtus; for if there had been ſeveral ſtone theatres at the time he wrote, he could not have diſtinguiſhed one by that title, to which they all had an equal right. And,

4thly, That the manner in which Vitruvius mentions the authors Accius and Ennius, and alſo Lucretius, Cicero, and Varro (the two former as ancient, the three latter as living in or near his own time), agrees perfectly well with the time of his writing, ſuppoſing it to have been in the reign of Auguſtus.

It muſt be allowed there is ſome force in theſe arguments, but they cannot be ſaid to be entirely concluſive; for the firſt argument only proves that Vitruvius did not write much before the time of Auguſtus, and in no wiſe renders it evident that he did not write long after. If he mentions none of thoſe buildings that were erected during or after the reign of Auguſtus, it may be ſuppoſed he had no occaſion to mention them; they might not be the examples he wanted.

In anſwer to the ſecond argument, it may be ſaid, that though Vitruvius does not treat of amphitheatres, yet neither does he treat of circuſes, which were buildings equally worthy of deſcription, and had been in uſe ſome ages before the time of Auguſtus. But, as he mentions both theſe kinds of buildings, it is certain that amphitheatres were in uſe in his time. Why he did not deſcribe them we know not: however, his not deſcribing them is no proof that they were unknown when he wrote; on the contrary, his manner of mentioning them, implies they were in common uſe in his days: and, as we know by hiſtory that thoſe buildings were not in common uſe till near the time of Titus, it conſequently amounts to a proof on the other ſide the queſtion, *viz.* that he did not write till near that time.

The third argument is anſwered by obſerving, that the theatre of Pompey, being the firſt built of ſtone, might of courſe be called the Stone Theatre at its firſt building, to diſtinguiſh it from all others, which at that time were of wood; and, having obtained that appellation at firſt, might ever after retain it. So, in our days, Newgate ſtill retains the name of one of our old city gates, and Pont Neuf of an old bridge at Paris, though the circumſtance from which they firſt obtained thoſe names (*viz.* their being then new) no longer exiſts. It is true we cannot be certain that this was the caſe with Pompey's theatre; but neither can we be certain that it was not the caſe. This argument, therefore, is balanced, and is concluſive neither on one ſide nor the other.

The fourth argument is not more concluſive than the former; for the manner in which Vitruvius mentions the authors there named, agrees as well with the time of Titus as with that of Auguſtus: for, as there was only a term of ſixty-five years between the reigns of thoſe two emperors, and as Vitruvius was old when he publiſhed his books, he might well conſider the former two of thoſe authors as ancient, in compariſon of the latter three, who might have been living in or near his own time.

The arguments on the contrary ſide of the queſtion are,

1ſt, The anſwer before made to the ſecond argument concerning amphitheatres: where Vitruvius (L. I. C. VII.) expreſſes that, *in thoſe cities which have no amphitheatre, the temple of Hercules is to be ſituated near the circus.* This implies that permanent amphitheatres were common in the cities of Italy at the time he wrote: but this could not be the caſe in the reign of Auguſtus, as the following circumſtances will render probable:—The firſt amphitheatre upon record was built by Julius Cæſar, for the exhibition of the ſhows at the dedication of his forum and temple of Venus. This muſt have been only a temporary building; for, after the fourth conſulate of Auguſtus, the ſhows given at Rome, on account of the victory at Actium, were repreſented in a wooden ſtadium or amphitheatre, built for the purpoſe in the Campus Martius. See Dio, l. liii. and liv. Statilius Taurus, indeed, about that time built a ſtone amphitheatre; but it was probably too ſmall for the public ſhows, as we read of temporary wooden ones being built upon occaſion by all the ſucceeding emperors down to Nero, who is ſaid to have built a very large one within a year; and Suetonius (in Veſpaſian, ſ. 9.) ſays this emperor erected the large amphitheatre that Auguſtus intended to build. It appears probable, therefore, that Rome had no permanent amphitheatre, either of wood or ſtone, in the reign of Auguſtus, except that of Taurus; and if Rome had not, it is not credible, nor is there any authority for believing, that ſuch expenſive and novel buildings were common in the other Italian cities at that time.

The firſt amphitheatre out of Rome, that is mentioned in hiſtory, was at Fidenæ: it was built by Attilius, in the reign of Tiberius, and fell down while the ſpectators were ſitting therein. This is mentioned by Suetonius and Tacitus. The latter author ſpeaks of another wooden amphitheatre at Placentia, as being the largeſt in Italy, and which was burnt in the wars between Otho and Vitellius: he alſo ſays, Cecinna employed the ſoldiers in erecting amphitheatres for the entertainment of Vitellius, ſo that it ſeems to be about that time that theſe buildings became common in ſeveral cities of Italy; which therefore renders it probable that the time of Vitruvius was near that period.

I have been favoured with ſeveral pertinent objections tending to inveſtigate the caſe, and which I ſhall notice as I proceed. One of theſe is, *that as Vitruvius (B. V. Ch. I.) ſays, the ſhows of gladiators are uſually given in the forum, it is probable that he wrote before amphitheatres were in uſe; becauſe it may be preſumed that, after that time, the forum was no longer uſed for that purpoſe.* But the anſwer to this objection is, what has been juſt obſerved, that he alſo (B. I. Ch. VII.) ſpeaks of amphitheatres as being in uſe, and even common, in the cities of Italy at the time he wrote. It appears evident therefore that the forum was ſometimes uſed for theſe ſhows after amphitheatres had become common.

2dly, A ſimilar argument may be maintained on the ſubject of theatres. In the 5th Book, Vitruvius treats fully of ſtone theatres built according to the Roman manner. This implies that more than one ſuch theatre had been erected when he treated of them; for one only would not be ſufficient to authorize the idea of a peculiar manner (*Quæ ex quadratis deſignantur, Græcorum; quæ ex paribus trigonorum lateribus, Latinorum habeant uſus. L. V. C. VIII.*). Yet there was but one ſtone theatre in Rome till very far in the reign of Auguſtus, when thoſe of Marcellus and Balbus were built. Vitruvius (B. V. Ch. V.) ſays that in his time there were ſtone theatres even in the Roman provinces (for they had the Echeian vaſes, and therefore muſt have been of maſonry, ſince he expreſsly ſays wooden theatres did not require thoſe vaſes). But it is not probable the provinces ſhould poſſeſs ſuch magnificent and expenſive buildings at a time when Rome itſelf had but one;

and that deemed ſo extraordinary, that Pompey was cenſured for building it, as both Pliny and Tacitus atteſt. It is more likely the faſhion reached not the provinces till long after it had been practiſed in the capital. Hence it is probable that Vitruvius wrote long after the erection of the theatres of Balbus and Marcellus, and even after ſtone theatres had become common in the cities of Italy.[1*]

It has been objected that Vitruvius (Book V. Ch. V.) ſays, *temporary wooden theatres were erected in Rome every year*, and it may be preſumed that that would not have been the caſe after the erection of the permanent theatres of Marcellus and Balbus. But the ſame argument might be uſed with regard to the theatre of Pompey, which undoubtedly was built beforeVitruvius wrote; alſo, this author's treating of permanent ſtone theatres (as before argued), fully evinces that ſuch were in being, notwithſtanding wooden ones were frequently erected.

Vitruvius, it is alleged, makes no mention of any edifice that was erected during or after the reign of Auguſtus. But this is a miſtake; for he mentions a temple erected to Auguſtus himſelf, one of Julius Cæſar, and other buildings erected in that time; as well as the theatres and amphitheatres already noticed.

In the deſcription which Vitruvius gives of the Baſilica which he built at Fano, he ſays, it was contrived ſo as not to obſtruct the view of the temple of Auguſtus. This temple then muſt have been built before Vitruvius began building his Baſilica. The Baſilica muſt have been ſome time in building, and it muſt have been finiſhed before he wrote his books; yet the emperor to whom he dedicates his books was but juſt peaceably ſettled in the government, as the proem to the firſt book indicates. Theſe circumſtances therefore, being compared, will not agree with the ſuppoſition, that Auguſtus was the emperor here addreſſed by Vitruvius: for it is not to be ſuppoſed that a temple was built to Auguſtus ſo long (as it muſt have been) before he was peaceably ſettled in the government; eſpecially as Auguſtus did not take that name till the third or fourth year after the battle of Actium. Beſides, Vitruvius mentions the name of Auguſtus without any term of reſpect, which he ſcarcely would have omitted if that emperor had been then living: the rather as he held a place of profit and honour by his favour; and as in every other part of his books, where he names the reigning emperor, he ſpeaks with reſpect, and directs his language to him perſonally. Farther, hiſtory informs us that two temples, and no more, were erected to Auguſtus in that emperor's life; one of which was at Lyons, and the other at Pergamus in Aſia: of this the ſpeech that Tiberius made to the ſenate, when Spain deſired leave to erect a temple to him, is a corroborating evidence.

Tacitus (An. l. iv.) gives this ſpeech thus: "*I know, conſcript Fathers, that many will accuſe me of inconſiſtency*

(1*) Here it may be obſerved, if Vitruvius wrote when ſeveral ſtone theatres were in being at Rome, that which he diſtinguiſhed by the appellation of *the ſtone theatre*, may not be, as generally ſuppoſed, that of Pompey, but more likely that of Marcellus, as being the largeſt, moſt conſiderable, and firſt entirely built of ſtone: for that of Pompey muſt have been partly of wood, from its having been ſo many times burnt; whereas that of Marcellus was wholly of ſtone. This ſuggeſtion appears the more probable, from the deſcription of ſtone theatres given by Vitruvius agreeing very nearly with the conſtruction of the theatre of Marcellus, in all that its preſent remains allow us to judge of. The degrees of Pompey's theatre may have been of wood, although the ſubſtructure and outer walls may have been ſtone; ſo that it may have been called a Stone Theatre by the authors of the time, conſidered in compariſon with others which were wholly of wood. This manner of ſpeaking is not unfrequent with authors; for Dio calls the bridge of Trajan over the Danube a ſtone bridge, although the piers only were of ſtone, the ſuperſtructure being of wood.

for not oppoſing the ſame requeſt from the cities of Aſia. I will therefore explain the reaſon of my ſilence then, and my reſolution for the future. The divine Auguſtus, whoſe words and actions are to me as ſo many inviolable laws, having conſented that the people of Pergamus ſhould dedicate a temple to him and the city of Rome, I thought I might follow ſo great an example; ſo much the rather, as the veneration paid to me was joined with that due to the ſenate: but as receiving ſuch honour for once may be pardoned; ſo to be adored in effigy as a god through all the provinces, would appear ambitious and proud, and detract from the honour of Auguſtus, by making ſuch adoration common.

This ſpeech evidently implies, that Auguſtus did not permit many temples to be erected to him; for had he done ſo, as Tiberius refuſed and condemned the repetition of that honour, it would have been condemning Auguſtus, whoſe words and actions he was ſo emulous to follow, and deviating from thoſe actions, by refuſing the honours which Auguſtus often permitted.

Suetonius (in Auguſ. ſ. 52.) ſays, Auguſtus permitted no temples to be erected to him in any of the provinces, unleſs dedicated jointly to him and the city of Rome. Yet Vitruvius aſcribes that at Fano to Auguſtus only; which is as ſtrong an evidence, as hiſtory can afford, that it was not erected in his reign.

Should it be alleged that Vitruvius might, from negligence, name Auguſtus only, although the temple may have been dedicated jointly to him and Rome, it may be anſwered, that if Auguſtus thought proper, from motives of delicacy or policy, to permit no temple to be dedicated to himſelf alone, it is not probable that any author in his time would preſume ſo to expreſs it.

After the death of Auguſtus, when Numericus Atticus had pretended that he ſaw his ſoul aſcend to heaven, temples were erected to him. Tacitus (An. i. xi.) ſays, after his funeral, a temple and religious rites were decreed him; and (l. i. ſ. 72.) ſays, that in the time of Tiberius a temple was built to Auguſtus at Taragon in Spain, which ſerved as an example to all the other provinces. It is therefore probable that it was at this time the temple of Auguſtus at Fano was built; and, if ſo, Vitruvius muſt have written ſeveral years after the reign of Auguſtus.

Vitruvius (Book III. Ch. II.) mentions the temple of Julius Cæſar: and ſeveral authors, as Plutarch, Suetonius, Dio, and others, ſay Auguſtus erected this temple on that ſpot in the forum where Cæſar's body was burnt. There is alſo a medal of Auguſtus that bears the reſemblance of this temple.[2*] See Nardini, p. 234.

In the ſame chapter, Vitruvius mentions the temple of Venus in Cæſar's forum; and this temple, although it was begun, and the foundation of it laid, by Julius Cæſar, is ſaid to have been finiſhed by Auguſtus. See Hook's Rom. Hiſt. vol. ii. p. 4.—We find there alſo mentioned the temple of Ceres at the Circus Maximus: and this

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(2*) The three columns in Campo Vacino at Rome are with much probability thought to be the remains of this temple; their intercolumniation being of that ſpecies Vitruvius aſſigns to it: and they ſtand oppoſite the temple of Concord, on the ſpot where ſeveral ancient authors deſcribe the temple of Cæſar to have ſtood. See Montfaucon's Antiq. vol. ii. ch. 17.

Tacitus (An. I. ii. ſ. 49.) enumerates with thoſe that were decayed and begun to be reſtored by Auguſtus, but dedicated by Tiberius; by whom it muſt have been finiſhed, ſince Tacitus ſays it was only begun by Auguſtus.

Vitruvius (L. III. C. I.) ſpeaks of the temple of Quirinus as an example of a dipteral temple. Dio Caſſius, book 54, ſays—"*Auguſtus dedicated that temple in the year of Rome* 738, *then built anew; and that it had ſeventy-ſix columns, exactly the number of years he lived; which cauſed ſome to ſay that it was not by chance but deſign that he uſed that number of columns.*" This number of columns will not agree with any but a dipteral temple; for in all the other kinds deſcribed by Vitruvius, the number of columns muſt be many more, or many leſs: but in the double range around a dipteral temple there are exactly ſeventy-ſix columns; ſo that it is ſcarcely to be doubted that this temple which Auguſtus rebuilt, was that to which Vitruvius alludes, and therefore he muſt have written after that time. Should it be alleged that the old temple of Quirinus (which was in being long before the time of Auguſtus) may alſo have been of the dipteral kind, and had the ſame number of columns, it may be anſwered, that the new temple muſt have differed from the old one in that reſpect; for if Auguſtus had only copied the old temple, it could not be attributed to him as an act of deſign, or be accounted ominous, that he uſed that number of columns. By the foregoing then it appears, that ſome of the buildings mentioned by Vitruvius were erected by Auguſtus, or in his time, or afterward; and it is thereby rendered exceedingly improbable that Vitruvius publiſhed his book in that reign.

Vitruvius (L. IX. C. III.) names Cicero, whom all the writers of the Auguſtan age avoided mentioning, leſt it ſhould give offence to the emperor, by whom he had been proſcribed. Plutarch (in Cicero) ſays—"*One of the grandſons of Auguſtus having a book of Cicero's in his hand when his grandfather entered the apartment, endeavoured to conceal it: Auguſtus however diſcovering it, took the book; and reading part of it, returned it, ſaying, That, my child, was a good man, and a friend of his country.*"—This is recorded as an inſtance of the moderation and temper of Auguſtus: but it is alſo an evidence of the public opinion, that the mention of Cicero might be offenſive to him; and renders it highly improbable that an author, and an officer dependant on him, ſhould, in a treatiſe that he profeſſes to write for his uſe, mention Cicero's name.

In book 55, Dio relates that "*Mæcenas, in the time of Auguſtus, firſt introduced the uſe of hot baths in Rome:*" and in book 53 he ſays—"*Aggrippa firſt erected at Rome the ſudatorium laconicum, ſo called from being uſed by the Lacedæmonians.*"—This was in the 9th conſulate of Auguſtus; yet theſe Vitruvius treats of, and deſcribes as being, and having long been, in common uſe at Rome when he wrote. It is therefore juſt to conclude, that he wrote long after this time.

In the proem of the ſeventh book Vitruvius ſays—"*Fuſſitius was the firſt among us who wrote on Architecture; then Terentius Varro, in his treatiſes of New Sciences, wrote one on the ſame ſubject, and Publius Septimus two: ſince which, to this time, no one has written thereof, although there muſt have been ſome great architects among the ancient citizens who were able to have written judiciouſly.*"

Theſe words evidently imply that a conſiderable number of years had elapſed from the time of Terentius Varro and Septimius to that when Vitruvius wrote this paſſage, ſince he ſpeaks of it as extraordinary that no one had written thereof in that interval. Now M. Terentius Varro, the famous author of many books,

lived and wrote in the time of Cicero and Auguſtus, to the former of whom he addreſſed ſome of his books; and he died in the 7th conſulate of Auguſtus. Had Vitruvius then dedicated his book to Auguſtus, being old when he wrote, he muſt have lived and written at the ſame time as Varro; and could not, at leaſt, have conſidered him as an ancient author, nor think it remarkable that no one had written on the ſubject ſince his days.[3*] But let it be alleged, Vitruvius might write ſome years after the death of Varro, and in the latter part of the reign of Auguſtus: in anſwer it may be ſaid, that Vitruvius wrote not to an old emperor, or to one near the cloſe of his reign; for in the dedication he ſays, *foreſeeing the care thou wilt in future have of public and private edifices*. So that no time in the reign of Auguſtus, that may be fixed on as the period when Vitruvius publiſhed, will be ſufficiently diſtant from the death of Varro, to authoriſe the mode of expreſſion Vitruvius uſes.

The reader is now referred to Note (2) Ch. V. Book VII.

To the foregoing arguments it may added, that the whole hiſtory of the time of Auguſtus will not agree with the ſtyle in which Vitruvius addreſſes the emperor in the proem to the firſt book.

He ſays—"*When firſt thou becameſt poſſeſſed of the empire of the earth*;" and afterward—"*When the gods had transferred to thy command the empire of thy father, and had raiſed him to their immortal ſeats:*" and alſo ſpeaks of his *governing the ſenate and people of Rome.*

This is language that Auguſtus, from motives of policy and perſonal ſafety, would not, dared not, permit; of which numerous inſtances may be collected from every author who has written of that period.

The words imply that the emperor addreſſed had ſucceeded his father in the empire immediately upon his death, as a right eſtabliſhed by cuſtom; that he received the government as an inheritance from his father; that he governed the ſenate as well as the people; and that (as may be preſumed from the words) the emperor he ſucceeded had died a natural, not a violent death, like that of Julius Cæſar.

Auguſtus, upon the aſſaſſination of Julius Cæſar, his great uncle, had no proſpect of ſucceeding to his ſituation in the republic; his mother Attia, and father-in-law Philip, conjured him not ever to aſſume the dangerous name of Cæſar (Patercul. ii. 60). Antony had ſeized the government; and deſpiſing Octavius, as he was then called, on account of his youth, refuſed him the poſſeſſion of the property that Cæſar had bequeathed him, and aſked him if he thought Cæſar had bequeathed him the empire as well as his name. Octavius commanded an army againſt Antony in favour of the ſenate and republic. After this, he and Antony governed conjointly; and it was owing only to the coincidence of a ſeries of accidental circumſtances that he attained the ſole authority. When he poſſeſſed that authority, he carefully avoided the appearance of it: he formally reſigned all his power after the battle of Actium, and would not reaſſume it otherwiſe than by the orders and requeſt of the ſenate; refuſing, even then, the whole of the interior government, which

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(3*) Varro lived to a very advanced age, and far in the reign of Auguſtus. Pliny (l. xxix. c. iv.) ſpeaks of him as publiſhing in his 88th year; and (l. vii. c. xxx.) ſays—Aſinius Pollio, who in the time of Auguſtus erected the firſt public library, placed in it the ſtatue of Varro, then living.

remained with the ſenate: and taking the command of the frontier provinces only, and that but for a term of ten years; which, when expired, was renewed for ten more, with great appearance of reluctance on his part; for he knew how odious and inſupportable the idea of an abſolute governor had ever been to the Romans, and that it had been the cauſe of Cæſar's death. When the ſenate, compelled by the infatuation and ſuperſtition of the people, beſought him to accept the dictatorſhip, he abſolutely refuſed it. He was angry if accoſted by any title that indicated ſovereign authority; and appeared much offended when an actor in the games ſtyled him Lord, the next day publiſhing an edict forbidding any one to give him any ſuch title. When he took the name of Auguſtus, he had a deſire rather to aſſume that of Romulus, declining it only on the fear of its rendering him ſuſpected of aiming at kingly power: and in one of his wills he had adviſed the ſenate not to commit the government to any individual. The ſame ſyſtem of policy was alſo obſerved by Tiberius, who aſſumed and held the power (as he affected) by the entreaties, and under the authority, of the ſenate; not daring to pretend a right to it, as an inheritance left him by his predeceſſor.

Theſe circumſtances appear ſtrong evidences that the language of Vitruvius was not directed to Auguſtus: the ſpirit of thoſe times would not admit it; the empire was not ſufficiently ſettled, and accuſtomed to a ſucceſſion of emperors, to authorize ſuch a mode of expreſſion. Nor does any author of that time (as far as I can find) ſpeak of or to Auguſtus in ſuch a manner, the moſt general appellation they uſe being that of Cæſar.

Vitruvius (Book III. Ch. II.) mentions a temple of Equeſtrian Fortune, as ſtanding at his time near the Stone Theatre in Rome: and Tacitus in his Annals, l. iii. ſ. 71, ſays there was no temple ſo called in Rome at the time of Tiberius's reign he is there recording. He ſays—*A doubt aroſe in what temple to place the offering which the Roman knights had vowed to Equeſtrian Fortune for the recovery of Auguſta (Livia); for, although many temples of that goddeſs were in the city, yet none of them had that appellation. A temple, however, was found at Antium that was ſo called; and as all ceremonies muſt, by the laws of the Roman empire, be performed at Italian towns, and temples or ſtatues of the divinities, the offering was placed at Antium.* This appears to be as ſtrong an evidence as can be drawn from hiſtory, that Vitruvius muſt have written after that part of the reign of Tiberius; for it is clear that the temple of Equeſtrian Fortune he ſpeaks of muſt have been erected in Rome after that time.

The reader is now referred to note (8) Ch. VI. Book V. and note (2) Book X. Proem, where the ſeats or coverings on the ſtone degrees of the theatre are mentioned, and which carries the time of Vitruvius beyond that of Caligula.

It may be farther remarked on this paſſage, that the mention of coverings of ſeats being laid on the degrees, makes it almoſt certain that there was ſome theatre in Rome in which the degrees were of ſtone, and which it was the practice to cover, when Vitruvius wrote; and it is alſo equally probable that the degrees of Pompey's theatre muſt have been of wood, from being ſo many times conſumed by fire, as before argued. This ſtrengthens the opinion that he wrote after the erection of the theatres of Marcellus and Balbus, in the time of Auguſtus.[4*]

(4*) In the account the Marquis de Venuti gives of the diſcovery of Herculaneum, he ſays, upon being let down into the theatre, he obſerved the degrees to be covered with wood, appearing like a great wooden ſtaircaſe —An inſcription ſtill remaining over the orcheſtra door of this theatre, records P. Numiſius as the architect. It is not improbable that it may have been the colleague of Vitruvius mentioned in his firſt proem; and whoſe name the copyiſts have written P. Numidius, and ſometimes Numidicus, or Minidius; all which variations may have ariſen from the incorrect formation of the letters in the old manuſcripts.

Some circumſtances in the reign of Nero ſeemed to argue that Vitruvius had written therein, or prior thereto. Nero, after the conflagration of Rome in his time, prohibited common or party walls, ordering each houſe to be incloſed with its own wall (Tacit. An. l. xv.). But Vitruvius (l. ii. c. viii. and l. vi. c. ix.) ſpeaks of ſuch party walls as being in uſe when he wrote: he alſo ſpeaks of, and deſcribes, timber walls (allowing the expreſſion), which it may be preſumed Nero would, from ſimilar motives, have forbidden; for he ordered the houſes to be rebuilt to a certain height without any timber, and with Alban and Gabian ſtone, which fire could not damage. From theſe circumſtances it might be preſumed that Vitruvius wrote before theſe prohibitions were made. But Pliny (l. xxxv. c. xiv.) ſpeaks both of party and timber walls, in the ſame manner: and yet he certainly wrote after Nero's death; for he mentions him as being deceaſed in ſeveral preceding parts of his book. It may therefore be concluded that Nero's regulations did not remain in force.

Again—Tacitus numbers the temple of Jupiter Stator vowed by Romulus, and built by the conſuls P. Megellus and Att. Regulus, among the buildings that were burnt in this conflagration: and Vitruvius (l. iii. c. i.) mentions a temple of this name as an example; but he ſays it was IN (which may ſignify AT or NEAR) the portico of Metellus. Now this portico was near the Circus Flaminius, where the fire did not reach; whereas the temple of Jupiter Stator, vowed by Romulus, was near the Forum, and mount Palatine, where the fire raged, and was within the bounds of the original city of Romulus. Varro, as quoted by Macrobius (Saturnal. l. iii. c. iv.) mentions a temple of Jupiter Stator at the Circus Flaminius; and Pliny alſo (xxxiv. vi.) ſpeaks of a temple of this name, and of the portico of Metellus, as in being when he wrote: hence it follows that the temple mentioned by Vitruvius was probably not that which Tacitus ſays was deſtroyed by the fire in Nero's reign; and therefore the argument will not apply. In the ſhort and tumultuous reigns of Galba, Otho, and Vitellius, it is not probable that Vitruvius publiſhed his work: nor can it be ſuppoſed that he wrote to Veſpaſian; for circumſtances will not agree. Vitruvius, in his firſt proem, mentions the ſiſter of the emperor whom he addreſſes, and Veſpaſian had no ſiſter.

The reign of Titus followed next; and no circumſtance that I have met with, or can recollect, oppoſes the ſuppoſition of his being the emperor to whom Vitruvius dedicated his work: on the contrary, many circumſtances ſeem to agree therewith; and it is confirmed by others that render it probable that it was to no ſucceeding emperor.

The firſt eruption of mount Veſuvius upon record happened in the laſt year of the reign of Titus. So wonderful a phenomenon could not be unknown to any author who wrote after that event. But Vitruvius (l. iii. c. vi.) ſays *there was a tradition that ſuch an event had happened in former times:* a ſufficient indication that he knew of no ſuch for certainty, and conſequently that it had not happened when he wrote the paſſage.

The portico of Metellus, juſt before mentioned, Vitruvius ſpeaks of as in being. Paterculus, who wrote in the reign of Tiberius, ſays (l. i. c. xi.) *this portico was ſurrounded by that of Octavia*; and Dio (l. lxvi.) relates that *all the buildings of Octavia were deſtroyed by a fire that happened in the reign of Titus*; from whence it is probable Vitruvius wrote before that fire happened. It is true, Titus is ſaid to have reſtored theſe buildings; but this could ſcarcely be done completely within his ſhort reign: it is related that he did not live to finiſh all the works he had begun, but that they were finiſhed by Domitian. Even had they been com-

pleted by Titus, the time from thence to the concluſion of the reign cannot be ſuppoſed ſufficient for the compoſition of Vitruvius's book, or the part of it from that paſſage to the end.

The above circumſtances render it probable that Vitruvius publiſhed his work in the reign of Titus: but he had probably been writing and compoſing it for ſeveral years prior to its publication; for he ſays *it had coſt him much ſtudy, and he was old and infirm when he publiſhed it. As he was alſo engaged in the occupation of an engineer in the army*, it cannot be ſuppoſed that he could compoſe ſo large a work in a few years, or during the ſhort reign of Titus; but moſt likely wrote it at different times, and in the intervals of leiſure that his profeſſion allowed him. This the following remarks will alſo contribute to render probable.

Vitruvius (book viii. chap. iv.) ſpeaking of the properties of a ſpring near Iſmuc in Africa, ſays *he had the account from C. Julius, the ſon of Maſiniſſa, to whom the lands of the town belonged; who was in the army with Cæſar the father, and uſed to be his (Vitruvius's) gueſt.* "*C. Julius, Maſiniſſæ filius, cujus erant totius oppidi agrorum poſſeſſiones, cum patre Cæſare militavit, is hoſpitio meo eſt uſus.*"—"Cum patre Cæſare," *with the father Cæſar*, is an extraordinary expreſſion, and ſeems to relate to a time when there were two Cæſars, father and ſon, reigning together: this was the caſe with Veſpaſian and Titus; they reigned jointly. Pliny frequently ſpeaks of them in that light (ſee book iii. ch. v. and Suet. in Tit. vi.); and the words are perfectly proper, in ſuch a caſe, to diſtinguiſh the father from the ſon Cæſar. C. Julius, by his father's name, and his poſſeſſions in that country, was probably an African; and joined this father Cæſar, whoever he may have been, in that country. Now it is known that Veſpaſian commanded in Africa, of which province he had the government before he came to the empire; and there he married his wife Domitilla, an African lady. Vitruvius was an engineer; he therefore may have been alſo there, in Veſpaſian's army.

It appears, by the proem to the firſt book, that Vitruvius had been known to this father Cæſar and his family, as he muſt have been to the general in whoſe army he ſerved as an engineer. All theſe circumſtances therefore agree well with the ſuppoſition, that Vitruvius wrote this paſſage in the time of Veſpaſian, although he might not publiſh his work till the time when Titus reigned alone; and that Veſpaſian was the emperor Vitruvius alludes to by the words *cum patre Cæſare.*[5*] Some have thought the words *cum patre Cæſare* referred to Julius Cæſar; but *divo Cæſare* would in that caſe have been properly uſed, as at book iii. chap. ii. for Cæſar was deified. Galiani however, under that idea, has endeavoured to aſcertain who C. Julius and Maſiniſſa were, and the time they lived, in order to fix that of Vitruvius. He gives up the idea of Maſiniſſa being the famous African king of that name who joined with Scipio, as having been dead too long before the time of Auguſtus to ſuppoſe he could have had a ſon in the army at that time; as alſo of *Julius* being written inſtead of *Juba*; and then ſuggeſts an alteration of the text, of *Maſintha* for *Maſiniſſa*, becauſe one of that name is mentioned by Suetonius in Julius Cæſar's life: but all the copies have *Maſiniſſa*, and there is no ground for the alteration.

(5*) The dedication, or firſt proem, as it is named, was probably written at the time of publication, although other parts of the book may have been written before. It appears to be erroneouſly called the proem: as that which has been marked the firſt chapter ſeems rather to have been intended as the proem of the firſt book; it conſiſting of introductory matter, like thoſe of the other books. In ſome other parts of the work alſo, what appears to have been intended by Vitruvius as part of the proem of a book, has been ſeparated by the copyiſts, and divided into chapters. See the firſt three chapters of the ninth book.

The circumſtances mentioned of C. Julius having poſſeſſions about the town of Iſmuc, and his being the gueſt of Vitruvius (in whatever way that may be underſtood) in his houſe or his tent, argue that he was not the ſon of a king, but rather a private man of that country.

It has before been remarked that Vitruvius was well acquainted with the buildings of Greece and Aſia, and had therefore probably been a traveller in thoſe countries. But, when his profeſſion is recollected, this is accounted for: being an engineer, he of courſe accompanied the army into different countries. If he was with Veſpaſian in Africa, it is not unlikely that he alſo attended him when ſent to command in Greece and the Eaſtern countries, where Veſpaſian was when elected to the empire: Vitruvius might therefore have at that time ſeen and become acquainted with the Grecian edifices. This ſuppoſition at leaſt agrees with all the other arguments here advanced; and it accounts for that acquaintance he claims in his dedication with the father of the emperor he addreſſes.

I am here obliged to take notice of a circumſtance mentioned by Galiani, in the life of Vitruvius prefixed to his tranſlation. He ſays that *Vitruvius is not known to be mentioned by any claſſic author except Pliny, who names him in his catalogue of antient writers; and by Frontinus, who mentions him as the author of the Quinarian Module, at the ſame time ſaying that Auguſtus introduced that module.*

The fact is, Pliny no where mentions Vitruvius, as I can find: the catalogue of ancient authors annexed to his hiſtory was not made by himſelf; but, as his commentator Hardouin obſerves, by ſome copyiſt[6*], who names Vitruvius in that catalogue of his own authority; believing that Pliny copied Vitruvius in ſome paſſages in which they both write ſimilarly. I may, for the ſame reaſon, ſuppoſe that Vitruvius copied Pliny. The latter generally names the author from whom he copies, and in his addreſs to Titus profeſſes ſo to do; yet he has, in ſeveral paſſages, uſed almoſt the ſame words as Vitruvius has written, without mentioning him: it is therefore a preſumptive evidence that he did not copy from him, and conſequently that Vitruvius did not publiſh his work prior to Pliny's time of writing.

Frontinus, it is true, does mention Vitruvius; ſaying, *ſome ſuppoſed him, and ſome Agrippa, to be the author of the Quinarian Module:* but he does not ſay that it was introduced by Auguſtus, or in his time.

Frontinus wrote in the reign of Trajan, between whom and Titus were only Domitian and Nerva: his naming Vitruvius, therefore, adds to the probability that the time of Vitruvius could not be later than that of Titus.

On the foregoing arguments readers will form their own judgment: it may be thought a point of no great importance. The aſcertainment of it, however, may not be entirely uſeleſs; as numerous concluſions are and have been drawn from the preſumption of the time of Vitruvius being coincident with that of Auguſtus, which, with all their conſequences, will be erroneous, ſhould not that be the fact; and this has induced me to beſtow ſome attention on the diſcuſſion.

(6*) The table of contents of the books of Pliny is defective in all the manuſcripts: it cannot be that compiled by Pliny; becauſe it is divided into chapters, a mode of diviſion the antients never uſed. Pliny, in his dedication to Titus, ſays that *he had ſubjoined the contents of the ſeveral* BOOKS: he alſo mentions the number of books to be thirty-ſix; but the copyiſts, numbering the table of contents made by themſelves as the firſt book, have made the whole work to conſiſt of thirty-ſeven. In this table the name of Vitruvius is inſerted with thoſe of other authors; but it is not to be found in the text of Pliny, at any of thoſe places to which the reference is made, nor in any of the thirty-ſix books of Pliny.

ADVERTISEMENT.

IT is many years ſince I publiſhed a Tranſlation of the firſt five books of Vitruvius; intending, if it met with approbation, to tranſlate the remaining part of that Author. Having the ſatisfaction to find the work approved, I have been induced to proceed with it, as my intervals of leiſure permitted: but the requiſite attention to the duties of my profeſſion, and a very precarious ſtate of health, have retarded its progreſs. And, during the laſt eight years, the erection of the new Chapel in Greenwich Hoſpital* has ſo fully occupied my time, as to allow me no opportunity of attending to this work. In proceeding with the tranſlation of the latter books of Vitruvius, ſome additional explanations, emendations, or remarks relative to the former have occurred. Part of theſe could be moſt conveniently fixed in the places to which they belong; they are therefore printed ſeparately for that purpoſe, and will be given to the purchaſers with the ſecond part of the work. The reſt are annexed in form of an Appendix. An Index is adjoined, numbered according to the books and chapters; by which means it will ſuit not only this, but in a great meaſure all other tranſlations and editions of Vitruvius.

WILLIAM NEWTON.

* In a work lately publiſhed, intitled *An Hiſtorical Account of the Royal Hoſpital for Seamen at Greenwich*, it may be obſerved (at p. 100) that the deſigning of the new chapel is aſcribed ſolely to the late Mr. Stuart. The reſpect which is due to truth, and a reputation fairly earned, obliges me to notice that aſſertion, and to embrace this opportunity of ſtating the caſe to thoſe who may think ſo trifling a circumſtance worthy of attention. In the year 1782, when the chapel was begun, Mr. Stuart was far advanced in age; and had, for many years preceding his death, been extremely infirm. On this occaſion therefore, which called for a union of experience and activity, I was authoriſed by the Directors of the Hoſpital to aſſiſt him. The general deſigns for the chapel I made that year; and continued to produce the reſt, from time to time, until its completion in 1790, two years after Mr. Stuart's death. The only parts of the building in which Mr. Stuart had any ſhare, were the ornaments of the cieling, the frame of the altar-picture, and the baluſters uſed in the two ſide galleries: theſe, with the carving of ſome ſtone mouldings, taken from Greek examples in his Antiquities of Athens, were all that he determined; the remainder were of my deſigning, or my ſelecting, where the antique has been ſelected. This being the fact, and the building having obtained ſome commendation, I conceive myſelf juſtified in thus publicly aſſerting my claim to a ſhare of the work; although I at the ſame time become reſponſible for a greater portion of its errors. I do not mean to charge the authors of the above-mentioned *Hiſtorical Account* with any deliberate intention to injure my fame, or deprive me of what little reputation I may deſerve: their book was publiſhed under the ſanction of the Governors of the Hoſpital. Mr. Stuart was the regular ſurveyor, whoſe duty it was to provide whatever architectural deſigns may be required; and therefore the laws and forms of that eſtabliſhment were complied with, in his appearing oſtenſibly to be the deſigner of that edifice, and alſo of the new building appropriated to the education of the charity boys, although it was entirely executed from my deſigns.

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E R R A T A.

IN THE PREFACE.

Page	line	
v	14	*for* Vitruviani, *read* Vitruvianæ
	22	— Euriditi, *read* Erudit^{m}. (or Eruditorum)
vi	31	— engraving, *read* engravings

IN THE OBSERVATIONS, &c.

viii	34	— agree, *read* agrees

IN THE TEXT AND NOTES.

3	36	— of uniſon, *read* of the hemitones
8	5	— the holes of, *read* the modulary holes of
	13	— Hercules, *read* and Hercules
15	38	— was, *read* were
18	3	— apricus, *read* aphricus
19	14	— tutular, *read* tutelar
	32	— obſerve, *read* remark
23	32	— oak ſhingles, *read* oaken ſhingles
28	1	— lays, *read* lies
	13	— burnt, *read* quenched
	35	— and lime made of flint-ſtones, *read* lime and flint-ſtones. N. B. The remainder of this *Note* to be expunged.
31	30	— laying, *read* lying
36	12	— whereas, *read* when
	13	— may be, *read* are to be.—Ib. *for* a great age, *read* a great age, they ſhould be done thus
	20	— laid, *read* lain
	25	— hurdle, *read* timber
37	3	— left perpendicularly and tranſverſely, *read* cauſed by the perpendicular and tranſverſe timbers
	7	— hurdles, *read* timbers
43	15	— lays, *read* lies
46	41	— ſuppoſitions, *read* ſuppoſititious
48	4	— alſo two columns, *read* alſo columns
	23	— empreſſion, *read* expreſſion
49	12	— periſtyle of a portico, *read* portico of periſtyles
50	31	— XXV. *read* XXVI.
55	8	— (o) *read* (q)
56	7	— ſcamillos, *read* ſcamilli
57	21	— adjections are found between, *read* adjections between
	36	— correſpond to ſuit the level, *read* correſpond to the level
	37	— correſpondence alluded to between, *read* correſpondence between
58	25	— the cymatium, *read* the cymatium (G),
59	3	— extremity of the cymatium (n), *read* the extremity (n) of the cymatium
62	7	— the (ſhaft of the column), *read* the ſhaft (of the column)
	44	— the projection of the cymatium, *read* the projection of the epiſtylium
	60	— does not here mean, *read* does not there mean
72	45	— a and b, *read* a and d
74	18	— is, *read* are
	22	— is, *read* are
75	40	— is always found, *read* is often found
76	41	— as the projecture, *read* as the thickneſs
77	50	— collocendi, *read* collocandi
	51	— accedat, *read* accedet
	72	— quatur, *read* quatuor
78	43	— as even the ſmall draught, Fig. XVI. evinces—*to be eraſed*
81	5	— behold it, *read* behold them
	44	— pronanos, *read* pronaos
82	22	— pronanos, *read* pronaos
	73	— ſuppoſed, *read* ſuppreſſed
83	4	— Leſbiam, aſtragal, *read* Leſbian, aſtragal
88	12	— walls, is equal, *read* walls and path around, is equal
	73	— has mentioned, *read* has not mentioned
89	49	— pſeudo-dipteral, *read* pſeudo-peripteral
95	14	— prodium, *read* podium
96	11	— Fig. XXV. *read* Fig. XXXV.
106	44	— determinate, *read* indeterminate
116	15	— to be the apartment containing the veſſels, *read* to be the veſſels
	64	— 3*, *read* 8*
	69	— cadariæ, *read* caldariæ
117	3	— the floors, if, *read* the cielings, if
	5	— for the cauſeway, *read* for the pulvinus
118	38	— labrumor, *read* labrum or
	53	— proves, *read* prove
119	11	— propingeum, *read* propnigeum
120	25	— terras, *read* tarras
121	20	— inclined ſide; it is filled, *read* inclined ſide it is filled
122	7	— the joints, *read* the bond joints

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE FIRST.

P R O E M.

WHEN thy divine mind and genius, O Emperor Cæſar,[1*] firſt became poſſeſſed of the empire of the earth, and thou hadſt with invincible valour, ſubdued all thy enemies; thy citizens gloried in thy triumph and victory; all nations ſubjected, attended thy command; and the people and ſenate of Rome, delivered from fear, were governed by thy ſuperior wiſdom and judgment. I preſumed not then, when thou wer't ſo much engaged, to publiſh this treatiſe of Architecture, which I have with great ſtudy compoſed; fearing to incur thy diſpleaſure, by the unfitneſs of the time. But now, ſeeing thee attentive, not only to public affairs, and the general ſecurity of the ſtate, but alſo to the convenience of public edifices, (for by thee, Rome, the ſeat of the empire, has been adorned with public buildings, as well as enriched with provinces) I judged it right to delay no longer preſenting to thee theſe things; the rather, becauſe, being known to thy father, and admiring his virtues, when the celeſtial council of the Gods, had raiſed him to their immortal ſeats, and transferred to thy command, the empire of thy father, the veneration which I retained for his memory, procured me thy favour; wherefore, with M. Aurelius, P. Numidius, and C. Cornelius, I was appointed to the care and reparation of the baliſtas, ſcorpions, and other military engines, and with them receive the reward. This thou didſt firſt confer on me, in conſequence of thy ſiſter's commendation. Being therefore ſo greatly indebted to thy beneficence, and to the end of my life freed from the fear of want; I began to write for thee this treatiſe, having obſerved how much thou haſt built, and art now building; and foreſeeing the care thou wilt have in future of public and private edifices, that the memory of thy great atchievements may deſcend to poſterity. I have written theſe precepts with preciſion, that by their help, thou mayeſt judge of the works already done, or that ſhall be done hereafter; for in theſe books I have revealed all the principles of the art.

(1*) Which of the Roman emperors it was, whom Vitruvius here addreſſes, is a point not ſettled. See the Remarks on the Life of Vitruvius, prefixed.

CHAPTER I.

Of Architecture, and of the Inſtruction of Architects.

ARCHITECTURE is an art comprehending many ſciences and various kinds of erudition; by the rules of which, the works of all other arts are examined. It conſiſts of practice and theory.[1*] Practice is the conſtant and accuſtomed attention to the manual operations, and to the ſeveral kinds of materials of which a work may be conſtructed. Theory is the ability to demonſtrate and explain the rules and reaſons of the proportions of buildings. Architects who have practiſed without theory, and who have been only experienced in the manual part, have not been able to acquire any reputation by their works; and thoſe who have truſted to theory and ſpeculation only, have followed the ſhadow and not the ſubſtance; but thoſe, who are perfectly acquainted with both, like men completely armed, ſpeedily, and with reputation, ſucceed in their endeavours; for as in all things, ſo eſpecially in architecture, there are two parts, the ſignified and the ſignifier; the former is that which is here propoſed to be treated of; the latter is the demonſtration of the principles of the ſciences explained; and he who profeſſes architecture, ought to be well exerciſed in both parts. He ſhould be ingenious, and docile of inſtruction; for neither ingenuity, without education, or education, without ingenuity, can render him a complete artiſt. He ought to have a knowledge of letters, be expert in drawing, learned in geometry, not ignorant of optics, inſtructed in arithmetic, well read in hiſtory, to have diligently attended to philoſophy, to have a knowledge of muſic, not a ſtranger to phyſic, underſtanding in the law, and be converſant in aſtronomy and the aſpects of the heavens; why theſe are neceſſary, the following are the reaſons.

AN architect ſhould have a knowledge of letters, that he may be able to inſure the remembrance of his obſervations. By drawing, he is enabled to form the repreſentation of the work he would execute. Geometry is of great uſe to architecture, and teaches the uſe of the ruler and compaſs (which chiefly facilitates the delineation of the plans of buildings) and the management of ſquares, levels, and lines. By optics is aſcertained the region of the heavens, from whence buildings ſhould receive their light. By arithmetic, the expence of the edifice is calculated, the meaſures adjuſted, and the difficult queſtions of the ſymmetry ſolved. Architects ſhould be well acquainted with hiſtory, for they often introduce many ornaments in their works, whoſe original they ſhould be able to recite; as, for example, if

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(1*) The words of the text are *Fabrica & Ratiocinatione*, which moſt of the tranſlators have agreed in rendering practice and theory: but the definitions of Vitruvius, give us to underſtand, that by practice, he does not mean the actual labour of the workmanſhip, but the knowledge thereof only, ſo as to be able to direct the workmen, and to know when the work is well performed, and the materials good; as by theory he means the knowledge of the proportions, forms, diſtributions, *&c.* of the ſeveral parts of buildings, and their effects, ſo as to be able to deſign or compoſe with judgment.

marble ſtatues of women in garments, which are called Caryatides, ſhould be introduced in a building, ſupporting the mutules and cornice, inſtead of columns; when the reaſon is demanded, it may thus be given. Carya, a city of Peloponneſus, having joined with the Perſians againſt the Grecian ſtates, and the Greeks having put an end to the war by a glorious victory, with one conſent declared war againſt the Caryatides. They took the city, deſtroyed it, ſlew the men, and led the matrons into captivity, not permitting them to wear the habits and ornaments of their ſex: and they were not once only led in triumph, but were loaded with ſcorn, and kept in continual ſervitude, thus ſuffering for the crime of their city. The architects therefore of thoſe days, introduced their effigies ſuſtaining weights, in the public buildings, that the remembrance of the crime of the Caryatides might be tranſmitted to poſterity. The Lacedemonians, likewiſe, under the command of Pauſanias the ſon of Cleombrotus, having, at the battle of Platea, with a ſmall number vanquiſhed a numerous army of Perſians, to ſolemniſe the triumph, erected, with the ſpoils and plunder, the Perſian portico, as a trophy to tranſmit to poſterity the valour and honour of the citizens; introducing therein the ſtatues of the captives adorned with habits in the barbarian manner, ſupporting the roof. Thus with merited infamy they puniſhed pride, terrified their enemies with the idea of their power, and the citizens beholding this monument of their courage, were inſpired with a love of glory, and became more animated in the defence of their liberty. Hence it is that many introduce Perſian ſtatues ſuſtaining the epiſtylium[2*] and its ornaments, and thus make an excellent variety in their works. There are alſo other ſimilar hiſtorical facts, with which it behoves an architect to be well acquainted.

Philosophy enlarges the mind of an architect, frees him from arrogance, and renders him courteous, juſt, and faithful. Avarice he ſhould particularly avoid, for no work can ſucceed without fidelity and integrity. He ſhould never be covetous, or have his mind intent on receiving of gifts, but with prudence ſupport his proper dignity and reputation. All this philoſophy inculcates; it alſo teaches the nature of things, which the Greeks call *phyſiologia*, and which ought to be well underſtood, for many and various natural queſtions are ſolved thereby; as, for example, by the courſes, turnings, and different levels of the water in aqueducts, the natural ſpirits are excited, the ill effects of which, none can prevent, but thoſe who by the ſtudy of philoſophy have learnt the principles and nature of things. Alſo whoever would read the books of Cteſibius, Archimedes, or others who have written on ſuch kind of ſubjects, will not be able to underſtand them, unleſs he has been previouſly inſtructed in philoſophy. An architect ought to underſtand muſic, that he may know the canonical[3*] and mathematical rules of the proportions, and that he may properly regulate the force of the baliſtas, catapultas, and ſcorpions; for on either ſide of their little capitals, are the holes of uniſon, through which, with the capſtans or levers, the ſinewy cords are ſtrained, and not ſtopped, or faſtened, till the engineers perceive all their ſounds are alike; for when the

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(2*) Epiſtylium is a term ſometimes uſed to ſignify the whole entablature; as in this place, and at the 11th note of the following chapter; but it more generally ſignifies the architrave only. Among the other remains of antiquity at Athens, an example of the order of the Caryatides is ſtill ſubſiſting.

(3*) Canonical, alludes to a certain rule or ſcale, by which the ancients uſed to regulate the muſical intervals.

arms, which are held by theſe cords, are both equally ſtrained, they give the ſtroke properly; but if the cords are not in uniſon, the projectiles will vary, from their intended direction: ſo alſo the braſen vaſes in the little cells under the ſeats of the theatres, are diſpoſed by mathematical rules, and the diſtinctions of their tones, which the Greeks call *Echeiâ*, are regulated by muſical concord and proportion, divided in the compaſs of diateſſaron, diapente, and diapaſon.[4*] So that the ſound of the voice from the ſtage, ſtriking the correſpondent vaſe, reſounds, and becomes ſtronger, clearer, and more melodious, in the hearing of the audience: neither can the hydraulic organs,[5*] and other ſimilar machines, be conſtructed without the knowledge of muſic.[6*]

The ſtudy of phyſic is neceſſary, to be able to underſtand the nature of climates, which the Greeks call *Climata*, and whether the air and water of places are wholeſome or noxious, for without good air and water no habitation can be healthy.

It is requiſite to have a knowledge of the laws, which are neceſſary for the regulation of the walls of public buildings.[7*] The gutters of the eaves, the ſhores, lights, water channels, and ſo forth, with which an architect ſhould be well acquainted, in order that he may be careful at the beginning of the building, not to leave the father of the family involved in controverſies after the work is finiſhed; and that the conditions be written with caution and equity, both with regard to the employer and the artificer; for when the conditions are juſtly deſcribed, both parties will remain free from altercation. By aſtronomy, is known the ſituation of the eaſt, weſt, ſouth, and north, the motions of the heavens, the equinoctial,

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(4*) The muſical intervals, called the fourth, fifth, and octave.

(5*) According to Tacitus and Suetonius, theſe organs were firſt known at Rome in the reign of Nero. See the Obſervations on the Life of Vitruvius, prefixed.

(6*) Galiani, in his notes on this paſſage, imputes the degeneracy of modern architecture, to the modern architects (in general) being ſo ignorant of muſic; and obſerves how greatly the ancients attended to it in proportioning their buildings, as may be inferred from the remains of their works; inſtancing in particular the ſepulchre of the ſervants of Auguſtus, as publiſhed by Bianchini, who ſhews how perfectly its proportions agree with thoſe of muſic.

Palladio, Alberti, and many others who have written on architecture, agree in the ſame opinion, and preſcribe the application of the muſical proportions to works of architecture.

There is great reaſon to believe, that the ſame proportions which are ſo pleaſing to the ear, will alſo pleaſe the eye, when applied to viſible objects. For nature acts by the eaſieſt and ſimpleſt means, and never varies the cauſe to produce the ſame effect, when the ſame cauſe will anſwer the end. In colours, nature uſes the ſame cauſe, and the ſame effect ariſes; their harmony conſiſting in the ſame proportions as prevail in muſical tones; why not therefore, in figures, in which caſe, the perceiver, the proportions perceived, and the ſenſe conveying thoſe proportions to the mind, are the ſame; and the only difference between this and the caſe of the muſical tones is, that the ſenſation of the proportions are conveyed to the perceiver by another conductor, (i. e.) another ſenſe? It may not therefore be wholly without reaſon to ſuppoſe, that the ſame proportions will have the ſame effect on either ſenſe, the eye, as well as the ear; in figures, as well as in ſounds and colours.

It may be obſerved, that the muſical concords are moſt pleaſing and harmonious comparatively, as their proportions are the ſimpleſt, compoſed of the loweſt numbers, and eaſieſt to be diſtinguiſhed; as, for example, the octave, which is, as one is to two, is a more perfect concord than the fifth, which is as two to three; and that laſt is more perfect than the fourth, which is, as three to four, &c. This obſervation then may ſerve as a hint to induce us (in caſe of uſing the muſical proportions in architecture, or in any regular objects) to prefer the ſimpleſt that will ſerve the purpoſe. See Note 6, Chap. I. Book II.

(7*) Galiani has obſerved, that the word *communis* ſhould be underſtood to ſignify exterior, and offers as proofs the places, where the ſame word is again mentioned; viz. at Chapter VIII. Book II. and Chapter IX. Book VI. I however cannot help underſtanding it differently, even in thoſe very places he quotes, and believe that the word *communis* is intended to ſignify common, or public. See the Notes at thoſe places.

the ſolſtices, and the order of the ſtars, without which knowledge, the art of dialling cannot be underſtood.

This art, therefore, being ſo extenſive, and enriched with ſo many various ſciences, I think none can on a ſudden juſtly profeſs themſelves architects, nor unleſs from their youth they have gradually ſurmounted theſe ſtudies, been nurſed in the knowledge of the many arts and ſciences, and thus have arrived at the perfect knowledge of architecture. Perhaps illiterate men may wonder how ſo many ſciences can be acquired and retained in the memory; but when it is conſidered that all the ſciences have a mutual connexion and communication, it will be more eaſily credited; for the whole circle of arts is as one body, compoſed of divers members; and thoſe who from their youth, are inſtructed in all the different arts, obſerve in them all an analogy and ſimilarity of principles, and find they are eaſily acquired. Hence the ancient architect Pythius, who erected the magnificent temple of Minerva, at Prienæ, ſays in his Commentaries, that an architect ought to excel in all arts and learning, thoſe who by their induſtry and practice, have brought things to their greateſt perfection. But that cannot be neceſſary; for an architect neither need be, nor can be, ſo good a grammarian as Ariſtarchus, though he muſt not be illiterate; nor a muſician like Ariſtoxenus, though not ignorant of muſic; nor a painter like Apelles, though not unſkilful in drawing; nor a ſtatuary like Miron, or Polycletus, though not a ſtranger to ſculpture; nor as learned in phyſic as Hyppocrates, though not unacquainted with that art; nor need he be ſingularly excellent in any of the other ſciences, though he ſhould not be entirely without their knowledge; for in ſuch a number of different things, it is not poſſible to attain to ſingular perfection in each. It is ſcarcely in our power to conceive and underſtand their principles; nor is it architects alone who cannot arrive at this pitch of eminence in all literature; for even ſome of thoſe who have profeſſed a ſingle art, have not been able to obtain the higheſt degree of reputation. If, therefore, of all thoſe artiſts who practiſe only one art, very few, in an age, become remarkably excellent, how can it be expected that an architect, who ought to be ſkilled in many ſciences, ſhould exceed, or even equal, thoſe artiſts, who with great aſſiduity and induſtry have applied themſelves to a ſingle art?

In this, therefore, Pythius ſeems to have been miſtaken; not conſidering that every art conſiſts of two parts, the practice, and the theory; of theſe, one is peculiar to thoſe who exerciſe each particular art, viz. the practice; the other, which is the theory, is common to all the learned. So the pulſation of the veins, and the movement of the feet, are common to the profeſſors of both phyſic and muſic; but if a wound is to be healed, or a dangerous malady cured, a muſician is not employed, for it is the peculiar practice of a phyſician; and on the contrary, the muſician, and not the phyſician, muſt modulate inſtruments of muſic, ſo that our ears may be delighted with their ſounds. Between aſtronomy and muſic, there is likewiſe a common reaſoning, upon the ſympathy and ſymphony of the ſtars, in quadrate and trine, diateſſaron and diapente. In optics, by the Greeks called *logos opticos*, and in all other ſciences, there are many things ſimilar, or which have, at leaſt, the ſame common principles. But as to the executive part, in which practice and experience leads to perfection, it belongs to thoſe who are devoted to the exerciſe of one particular art. It is

therefore ſufficient for an architect to have a moderate knowledge of the parts and principles of the ſeveral arts which are aſſiſtant to the practice of architecture, that, if he ſhould have occaſion to judge of thoſe arts, or to examine a performance, he may not be found ignorant or deficient. Some there are to whom nature has given ſo much ſagacity, penetration, and memory, that they are able to acquire a complete knowledge of geometry, aſtronomy, muſic, and many other ſciences; theſe exceed the department of architects, and become mathematicians. Being therefore furniſhed with ſo much knowledge, they can with facility diſcourſe on many ſubjects; but even among theſe there rarely happens to be ſuch men as Ariſtarchus of Samos; Philolaus, and Architas, the Tarentines; Apollonius of Pergeus; Eratoſthenes of Cyreneus; Archimedes and Scopinas of Syracuſe; who have left to poſterity many mechanical and gnomonical inventions, which, by their knowledge of numbers, and the laws of nature, they have diſcovered and explained.

As therefore ſuch talents and natural abilities are not granted to all men, but to very few, and as the profeſſion of an architect requires that he ſhould be acquainted with all erudition, though, on account of the extenſiveneſs of ſcience, it is admitted that a perfect knowledge of all is not to be expected, and that a moderate degree is ſufficient, I requeſt indulgence from thee, O Cæſar, and thoſe who read my books, if any thing ſhould not be here deſcribed according to the ſtrict rules of grammar, for I pretend not to write like an eminent philoſopher, an eloquent rhetorician, or excellent grammarian practiſed in the principles of the art; but as an architect, moderately acquainted with letters. So far, therefore, as the art and the rules thereof will admit, I promiſe, (as I hope) that theſe books will be written to the ſatisfaction, not only of profeſſors, but of the learned in general.

CHAP.

CHAPTER II.

Of what Architecture conſiſts.

ARCHITECTURE conſiſts of Ordination, which the Greeks call *taxis*; of Diſpoſition, which the Greeks call *diatheſin*; of Eurithmy, Symmetry, Decor, and Diſtribution, which the Greeks call *oiconomia*. Ordination[1*] is the proper modification of the members of the work, ſeparately, and the regulation of the whole proportion and ſymmetry. This ariſes from quantity, which the Greeks call *poſotes*. Quantity relates to the meaſures uſed in the ſame work, and the ſuitable effect of the ſeveral members, and of the whole building. Diſpoſition[2*] is the apt collocation of the parts, producing the proper qualities in the compoſition of the work; the kinds of diſpoſition, by the Greeks called *ideai*, are theſe, Ichnography[3*], Orthography[4*], and Scenography[5*]. Ichnography is the uſe of the compaſſes and ruler, in deſcribing the horizontal figures of objects. Orthography is the delineation of the front, according to the true meaſures of the intended work. Scenography is alſo the repreſentation of the front, with the ſide receding in ſhadow, and all the lines tending to a central point. Theſe ariſe from cogitation and invention. Cogitation is profound reflection, joined with induſtry and vigilance, delighting to produce the deſired effect. Invention is the ſolution of intricate queſtions, and the diſcovery of novelties. Theſe are the limits of diſpoſition.

EURITHMY[6*] conſiſts in the beautiful form and handſome appearance of the members of a compoſition. This is effected when the heights of the members are adapted to their breadth, and their breadth to their length, each being correſpondent to the ſymmetry

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(1*) All the commentators of Vitruvius allow this explication of architecture to be very dark and unintelligible; and all differ in their interpretation thereof; its obſcurity may very likely be owing, in a great degree, to our ignorance of many circumſtances of thoſe times, their uſe of the technical terms, or the different acceptation of words. The words are here put together in ſuch a manner, as ſeem to us to have no coherence or ſenſe; we can, therefore, do no more than make conjectures concerning their true meaning, guided by the little aſſiſtance they will afford us.

Ordination I ſupppoſe to be uſed in the ſenſe we now uſe the word order; it expreſſes the kind of compoſition employed in the building, as the Doric kind, the Ionic, or Corinthian kinds, &c. It may be ſaid to relate to quantity, becauſe the order governs the proportional magnitude of the parts; for, according to the kind or order of building uſed, the parts are varied in their proportional magnitude.

(2*) Diſpoſition here ſeems to be uſed by Vitruvius, in the ſenſe of compoſition; he mentions this latter word in his definition. Diſpoſition, in the ſenſe we generally accept it, is included in the article of Diſtribution, hereafter defined.

(3*) The art of drawing the geometrical plans of objects.

(4*) That of drawing their geometrical elevations.

(5*) The art of drawing their perſpective appearances.

(6*) Eurithmy, by the deſcription of Vitruvius, anſwers to proportion, which is the harmonious correſpondence of the height, breadth, and length of objects, and the agreement of the parts with each other, and with the whole.

of the whole. Symmetry[7*] is alſo the proper agreement of the ſame members of a work, and the proportional correſpondence of the ſeparate parts to the form of the whole object; as in the human body, the arm, the foot, the palm, the finger, and the other members are in ſymmetry. And ſo it muſt be in all perfect works, but particularly in ſacred edifices; as in the thickneſs of the columns, the order of the triglyphs, the holes of the balliſtæ, which the Greeks call *peritreton*, or the interſcalmii[8*] of galleys, called *dipechaice*, and in ſimilar works; in all which, the members are regulated by the rules of ſymmetry.

Decor[9*] conſiſts in the proper appearance of a work, and its being compounded of approved and authoriſed parts. This has regard, either to ſtation,[10*] which the Greeks call *thematiſmos*, cuſtom; or nature. To ſtation, when temples which are erected to Jove the thunderer, the heavens, the ſun, or the moon, are built uncovered, and expoſed to the air, becauſe the influences and effects of thoſe deities are perceived in the open air; when to Minerva, Mars, Hercules, Doric temples are built; for on account of the attributes of theſe deities, edifices conſtructed without delicacy are moſt ſuitable. To Venus, Flora, Proſerpine, and the nymphs of the fountains, the corinthian kind are erected with propriety; for by reaſon of the delicacy of thoſe goddeſſes, the graceful, gay manner, with foliage, and ornamented volutes, give a due decorum to the work. To Juno, Diana, Bacchus, and ſuch other deities, Ionic temples are conſtructed, as poſſeſſing the mediocrity; for being tempered of the ſeverity of the Doric, and the tenderneſs of the Corinthian, they become moſt ſuitable. Decor, with regard to cuſtom, is obſerved when the internal parts of edifices being magnificent, the acceſſes are alſo made ſuitable and elegant; for if the interior parts are elegant, and the approaches are mean and ignoble, it will not have decor. So likewiſe if dentils are carved in the cornice of the Doric epiſtylium,[11*] or in the abacus of the capital, or if triglyphs are repreſented in the epiſtylium of Ionic collumns, transferring the characteriſtics of one kind of work to another; it offends the eye, becauſe cuſtom has eſtabliſhed a different order of things. Decor, with regard to nature, conſiſts in all temples being placed in a ſalutary ſituation, with fountains of water in the places where the fane is built; but eſpecially, the temples of Eſculapius, of Health, and ſuch deities, by whoſe healing influence numbers of ſick appear to be recovered. For the diſeaſed bodies being removed from an unhealthy to a healthy ſituation, and the ſalutiferous water of the fountains

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(7*) The definitions of eurithmy and ſymmetry, are very ſimilar; proportion ſeems to be the meaning of both. Vitruvius frequently uſes the words proportion and ſymmetry, ſynonimouſly; and his difinitions and applications of thoſe words, give us to underſtand, that the only difference he makes between them, is, that the former ſignifies the proportion of each member in itſelf, (that is, the proportion which the height, length and breadth bear to one another) and the latter, the proportion of one member to another, and to the whole object. Vitruvius alſo uſes the word ſymmetry in the ſenſe of manner, arrangement, formation, configuration, &c. and in the third and fourth Books, he uſes it for order, ſaying, the Doric or Ionic ſymmetry, &c.

(8*) *Interſcalmii*, are the intervals of the oar holes in galleys.

(9*) Decor, I judge to be propriety. As eurithmy and ſymmetry produce beauty, ſo decor is that which produces the appearance of propriety, and ſelects the qualities and appendages becoming the object.

(10*) *Statione*, Galiani has rendered *ſtatute*, and Perault, *the ſtate of things*. I have tranſlated it ſtation, judging by the ſenſe of the context, that Vitruvius means the ſtation, rank, quality, office, or dignity of the perſon for whom a building may be erected; or, if a temple, the attributes, power, or department of the deity to whom it is dedicated.

(*11) Epiſtylium is evidently here uſed to ſignify the whole entablature.

being adminiſtered, they are ſoon reſtored. By this means it will happen that the natural effects of the place will encreaſe the received opinion of the power of the Divinity.

Decor, with regard to nature, is alſo obſerved when chambers and libraries receive their light from the eaſt; baths, and winter aparments, from the winter weſt; picture galleries, and ſuch apartments as require a ſteady light, from the north, becauſe that region of the heavens is rendered neither lighter nor darker by the courſe of the ſun, but is equal and immutable the whole day.

Distribution[12*] conſiſts in the proper diſpenſation and application of the materials, obſerving moderate œconomy with regard to the expence of the work. This will happen, if the architect does not require materials that cannot be obtained, or procured, unleſs at a great charge; for there are not plenty of pit-ſand, ſtones, fir, ſappinus[13*], or marble in all places; but ſome grow in one place, and ſome in another; and to procure ſome, it may be difficult or expenſive. Where therefore there is no pit-ſand, river, or waſhed ſea ſand muſt be uſed; and for want of fir, or ſappinus, the cypreſs, poplar, elm, or pine may be made uſe of; and ſo in other ſimilar caſes.

Another part of diſtribution is the adapting the building to the convenience of the owner, his fortune, rank, or dignity; it is alſo found to be neceſſary to conſtruct the dwelling houſe[14*], different from the ruſtic buildings deſtined for the preſervation of the fruits of the earth. The houſes of traders, different from thoſe of the rich and delicate. But for perſons in power, by whoſe councils the republic is governed, things muſt be diſpoſed to their uſe; always making the diſtribution of edifices ſuitable to every proprietor.

(12*) Vitruvius gives the word diſtribution a very different ſignification, to that we now generally allow it. He applies it to the diſpoſal and choice of the materials; and alſo, to adapting the building to the fortune, dignity, and uſe of the owner; which latter ſeems rather to belong to the province of decor, as he has before explained it: it however may be conſidered as belonging to both; for a building cannot be ſaid to be well diſtributed, unleſs it is ſuited to the owner; neither can it have propriety or decor, without being ſo ſuited.

(13*) Sappinus is the name the Romans gave to the lower part of the ſtem of the fir tree, which being moſt free from knots, was prepared in a particular manner, and reſerved for the inſide work. See Vitruvius, Book II. Chap. IX. and Pliny, Book XVI. S. XVI.

(14*) I differ from former tranſlators in my conception of this paſſage. They have conſtrued it as if meant to oppoſe a city houſe to a country houſe; I underſtand it, as oppoſing one part of the country houſe to another part (i. e.) the dwelling, or maſter's part, to the farming and huſbandry part. The ancient villas contained three parts; one was called the *urbana*, or part where the maſter and his family dwelt; the other the *ruſtica*, deſtined for the uſes of huſbandry; and the third, the *fructuaria*, or receptacle for the fruits of the earth. I am therefore of opinion, that the words *urbanas domos*, allude to the maſter's part, as *poſſeſſionibus ruſticis* do to the huſbandry part of the villa. For, as theſe were well known terms for thoſe different parts of the villa, it is to be ſuppoſed, that Vitruvius would have choſen ſome other words to diſtinguiſh his meaning, if he had meant any thing elſe by them.

Vitruvius alſo diſtinguiſhes *poſſeſſionibus ruſticis*, from *urbanas domos*, by the former's being deſtined for the reception of the fruits. Now, that not being the chief purpoſe of the whole country houſe, but only that of an inferior part, it cannot properly be uſed to diſtinguiſh the purpoſe of a country houſe, in oppoſition to that of a city houſe; but, is perfectly proper to diſtinguiſh between the farming part, and the dwelling, or maſter's part of the villa.

CHAPTER III.

Of the Parts and Principles of Architecture.

THE parts of architecture are three; Building, Dialling, and Mechanics. Building is divided into two parts, of which one relates to fortification and the conſtruction of public works; the other is relative to private edifices. The diſtributions[1*] of public works are three; one is defence, another, religion, and the third is convenience. Defence regards the erection of the walls, towers, and gates, which are to be contrived ſo as conſtantly to repel the aſſaults of an enemy. Religion, the ſacred edifices and temples of the immortal Gods; and convenience, the common buildings for the public uſe; ſuch as the Port, Forum, Porticos, Baths, Theatres, Ambulatories, and ſuch like; which therefore are always diſpoſed in public places. All theſe ought to be conſtructed with ſtrength, utility, and beauty. They will have ſtrength when their foundations are ſunk to the ſolid earth; and when from plenty of materials, a careful choice is made without ſparing. Utility, when the apartments are properly diſtributed, without obſtruction to their uſe, and are expoſed to the aſpects which are convenient and adapted to their reſpective purpoſes. Beauty, when the form of the work is agreeable and elegant, and the proportions of the members are correſpondent to the rules of ſymmetry.

(1*) Vitruvius, in this place, uſes the word diſtribution in the ſenſe of the word deſtination. I have here choſen to make uſe of the word of the text, in order to give the reader an idea of the various and unuſual ſignifications in which the words are often uſed.

CHAPTER IV.

Of the Choice of healthy Situations.

BEFORE the walls of a city is began, a healthy ſituation ſhould be choſen; it ſhould be elevated, not cloudy or rainy, and turned to that aſpect of the heavens which is neither hot nor cold, but temperate. The neighbourhood of marſhes is alſo to be avoided; for at ſun-riſe when the breezes of the morning, joined with the riſing clouds, paſs over the city, the venemous effluvia of the vermin in the marſhes, mixed with the clouds, being blown and diffuſed among the bodies of the inhabitants, renders the place unhealthy. Cities likewiſe that are ſituated on the ſea-coaſt, and expoſed to the ſouth or weſt, will not be healthy; becauſe in the ſummer, the morning ſun heats, and the meridian ſcorches the ſouthern aſpects. So alſo if they are expoſed to the weſt, they are warmed at ſun-riſe, heated at noon, and ſcorched in the evening; ſo that by the variations of heat and cold, things in thoſe places are ſoon vitiated. This may alſo be obſerved in inanimate objects; for in covered wine vaults, no one admits the light from the ſouth or weſt, but from the north, becauſe this aſpect never ſuffers any change, but is always ſteady and immutable. For this reaſon, in granaries that are expoſed to the ſouth, the foods and fruits which are not depoſited in a part that is defended from the heat of the ſun, are not long preſerved; for heat always dries and deſtroys the conſiſtence of things, and the fervid vapours extracting the natural moiſture, diſſolves, ſoftens and renders them ſpiritleſs. This we obſerve even in iron, which though hard in its nature, yet being intenſely heated by the fiery vapours of the furnace, is ſo ſoftened as to be eaſily wrought in all kinds of forms, and when it is thus ſoft and burning hot, if it is cooled again by being ſteeped in water, it is rehardened and reſtored to its former ſtrength. It may likewiſe be obſerved, that in ſummer (not only in noxious, but even in healthy places) all bodies are infeebled by the heat; and by the winter, even the moſt peſtilential places are rendered healthy, becauſe they are rectified by the cold; alſo bodies that are conveyed from cold to hot climates, cannot exiſt, but are diſſolved; on the contrary, thoſe that go from hot places to the cold northern regions, are not only recovered from their diſeaſes, but are alſo invigorated. We ſhould be careful therefore, not to expoſe cities to thoſe regions which may diffuſe hot blaſts among the bodies of the inhabitants; for of the elements, which the Greeks call *Stoicheia*, all bodies are conſtituted; that is, of fire, water, earth and air; and theſe, variouſly mixed and tempered by nature, produce the different properties of all animals in the world. Thoſe bodies in which the element of fire predominates, are thereby diſſolved and deſtroyed; which evil is cauſed by the heat from certain parts of the heavens, entering the pores in a greater quantity than ſuits the natural temperament of the body. So alſo if too much humidity occupies the veſſels of the body, it occaſions an inequality, and the moiſture corrupts, dilutes, and deſtroys the virtue and texture of the other elements; even the cold humidity of the winds and air infuſes diſorders in the body.

The ſame may be ſaid of air and earth, the augmentation or diminution of which, in the natural conſtitution of the body, diſorders the other elements; earth, by too much food; and air, by the denſity of the atmoſphere.

But whoſoever would ſenſibly perceive theſe things, muſt obſerve, and conſider the nature of birds, fiſh, and the terreſtial animals; and he will diſcern their diſtinct temperatures; for the ſpecies of birds have one conſtitution, fiſh another, and the terreſtial natures another far different. The winged animals have little earth and water, a moderate degree of fire, and much air; being therefore compounded of the lighter elements, they eaſily ſuſtain and move themſelves in the air. The aquatic animals, or ſpecies of fiſh, are compounded of a moderate degree of fire, much air and earth, and very little moiſture; ſo that having but a ſmall portion of the element of water in their bodies, they can more eaſily exiſt therein, and when they are brought to land, they relinquiſh their life with the water. The terreſtial animals are conſtituted of the elements of fire and air, of little earth, and much moiſture; abounding therefore in humidity, they cannot long exiſt in water. If, therefore, things appear to be formed in the manner we have explained, and we allow that animal bodies are compounded of theſe elements, the exceſs or deficience of which cauſes diſorder, we cannot doubt of the care that ought to be uſed, to elect the moſt temperate aſpects, when we deſire cities to be healthily ſituated. We ſhould, moreover, recall to mind the rules of the ancients, who inſpected the livers of the ſacrificed cattle which had fed in the places where a town or abiding camp was to be eſtabliſhed; and if the firſt was livid, or corrupt, they ſacrificed others; doubting whether diſeaſe, or bad paſturage had occaſioned it. When they had tried many, and had proved that the healthy and ſound ſtate of the livers proceeded from the goodneſs of the water and paſturage, they there erected their fortification; but if the livers were found vitiated, it indicated that the ſame diſeaſes would in future ariſe in the bodies of men, from the uſe of the water and vegetables of thoſe places. They therefore removed to other countries, changing places, and ſeeking health above all other things.

That the peculiar ſanity of a ſpot is to be diſcovered by the paſturage and produce, may be obſerved and known, from the example of the country about the river Pothereus, in the iſland of Crete. The river is ſituated between the two cities Gnoſon and Cortynam; and upon the right and left the cattle feed; but thoſe that feed next Gnoſon have a milt; and thoſe on the other ſide, next Cortynam, have no appearance of any. The phyſicians, upon ſearching after the cauſe, diſcovered in thoſe places certain herbs, on which the cattle feeding, diminiſhed their milt; upon this, they collected thoſe herbs, and make uſe of them as a medicine to cure the ſpleen, which herb the Cretans therefore call *aſplenon*. From this example it may be concluded, that the vegetables and water of countries naturally occaſion them to be noxious or healthy.

Cities that are built in lakes, near the ſea, and expoſed to the north, or between the north and eaſt, provided the lake is higher than the bed of the ſea, will not be ill ſituated; for by making trenches, the water will run off to the ſea-ſhore; and the ſea when

ſwoln[1*] by tempeſts reflowing into the lake with violent motion, and mingling with the ſtagnated water, will not ſuffer any kind of vermin to breed; for ſuch vermin as breed in higher places, upon coming near the ſea-coaſt are deſtroyed by the unaccuſtomed ſaltneſs. Examples of this kind are the Gaulic lakes, which are near Altina, Ravenna, and Aquileja. There are alſo other towns in the neighbourhood of lakes, which are for this reaſon, incredibly healthy; but ſuch lakes as, like the Pontinæ[2*], are ſtagnant, and have no efflux, either by rivers, or trenches, become putrid, and emit groſs and peſtilential vapours in thoſe places. The ancient city of Salapia, in Apulia, which was founded by Diomedes, at his return from Troy, or, as ſome write, by Elphias, the Rhodian, was diſpoſed in ſuch a place, that the inhabitants were every year afflicted with diſeaſes; at laſt they applied to M. Hoſtilius, and, in the name of the public, requeſted, that he would ſearch for, and elect them a proper place to which they might transfer their city. To this he conſented, and without delay, ſought, according to the moſt approved methods, for a healthy ſpot upon the ſea-coaſt; purchaſed the poſſeſſion; petitioned the ſenate and people of Rome for leave to transfer the town; raiſed the walls, divided the areas, and then, for a ſeſtertius each, gave free poſſeſſion to the citizens. This done, he opened the lake to the ſea, made it the port, and ſo perfected the city. The Salapines therefore now inhabit a healthy ſituation, four miles diſtant from their old town.

CHAPTER V.

Of the Conſtruction of the Walls and Towers.

WHEN therefore, by the above means, the ſituation choſen for the city is found to be ſalutary, the ſoil fertile, yielding food ſufficient for the ſuſtenance of the inhabitants, and the approaches eaſy, or having the accommodation of a river, or ſea-port, to expedite the carriage of goods to and from the city; then the foundations of the towers and walls are to be thus conſtructed: the ground is to be dug down to the ſolid earth, and in the ſolid, ſo far as ſeems reaſonable for the magnitude of the work. The foundation walls are to be thicker than thoſe which are built above ground, and they muſt be executed in the firmeſt manner.

(1*) There are little or no tides in the Mediteranean ſea; to which Vitruvius had chiefly regard; he therefore ſuppoſes that ſea to be raiſed only by tempeſts.

(2*) Pontinæ was a lake in the Campania, eighteen miles diſtant from Rome.

Fig. I. On the outſide, towers (D) are erected, that when enemies hoſtily approach the walls, they may be wounded by the darts from the towers, on their right and left; particular care is to be taken that the aſſailants may not eaſily advance to batter the walls, encompaſſing the place with a ditch, and contriving the approaches to the gates, not to be direct, but *ſcaia*[1*]; for when they are thus made, the right ſide of the beſiegers, which is not covered with a ſhield, will be expoſed to the walls.

Cities are not to be formed quadrangularly, or with projecting angles, but circuitouſly[2*], that the enemy may be deſcried from many parts: for thoſe projecting angles are difficult to defend, and are a greater ſecurity to the enemy than to the city. The thickneſs[3*] of the walls I judge ſhould be ſuch, that when the armed men happen to meet, they may paſs each other without obſtruction[4*]. In the thickneſs, olive piles ſcorched, and ranged very cloſe, are laid; ſo that the walls having both fronts thus bound together, are exceſſively ſtrong: for this wood is not affected, either by the weather, rot, or age; but whether it is buried in the earth, or ſunk in the water, it remains always ſound and ſerviceable. If, therefore, not only the walls above ground, but alſo the foundations, and other thick walls, were united in this manner, they would not ſpeedily decay.

Fig. I. The diſtances[5*] of the towers (D) are ſo regulated as not to be greater than the darts will reach; that in caſe of an aſſault, the enemy may be repulſed by the ſcorpions and other miſſiles from the towers on the right and left. Alſo oppoſite to the interior

Fig. IV. part (E) of the towers the wall is to be divided, the interval being as large as the tower; and the paſſage way (F) in that place is to be made with timber, and not faſtened with iron; that if the enemy ſhould gain that part of the walls, it may be cut by the beſieged ſo ſpeedily, as not to permit the aſſailants to penetrate farther without precipitating themſelves. The towers are made either round or polygonal; for the machines ſoon deſtroy thoſe which are made ſquare, and their angles are broke by the battering rams. But the round, like wedges driving to their center, cannot be eaſily damaged.

(1*) *Scaia*, ſignifies oblique, or inclining to the left. See the letters C, C, Fig. I.

(2*) Vitruvius's word is *circuitionibus*, by which, I do not ſuppoſe he means that cities are always to be upon the plan of a circle, or any regular polygon; but that they ſhould be convex in every part, though their figure may be various and irregular, according as their ſituation, the nature of the adjacent country, or other circumſtances may make proper.

Several of the tranſlators have in their draughts, repreſented the city upon the plan of an octagon, dodecagon, &c. placing the towers at the angles only. Vitruvius, a little farther on, ſays, that the diſtance of the towers from each other ſhould not be greater than the throw of a dart, which we may ſuppoſe was about eighty or a hundred feet; as the towers which Julius Cæſar erected at the ſiege of Bourges, were at that diſtance. It follows, therefore, that the cities, according to the ſuppoſition of the ſaid tranſlators, muſt be included within the periphery of eight or twelve hundred feet; which, though large enough for a fortreſs, or citadel, would make but a very diminutive city.

(3*) In the ancient manner of fortification it was uſual to make a paſſage in the thickneſs of the walls, near the top, open with arches next to the town, and having ſmall apertures next to the enemy. In this paſſage, as well as on the top of the wall, the ſoldiers were poſted for the defence of the place. Such a paſſage is ſtill to be ſeen in the remains of the ancient walls of Rome, built by the emperor Aurelian. See b, b, in the plan and elevation, Fig. IV.

(4*) Vitruvius ſays, the walls ſhould be ſo thick that the ſoldiers may paſs each other with eaſe; but it muſt be ſuppoſed that he means excluſive of the thickneſs of the battlements, which defend and ſcreen the men from the enemy.

(5*) Julius Cæſar, at the ſiege of Bourges, erected turrets eighty feet apart, as before mentioned. See D, D, Fig. I.

IF a bulwark[6*] (H, I,) is adjoined to the walls and towers, it will render them more ſecure; for they cannot then be much annoyed either by the rams, mines, or other machines; though it is not neceſſary to make theſe bulwarks in all places; but only where there is ſome elevated place without the walls; from whence the city may be eaſily aſſaulted. In thoſe places, therefore, a ditch of a great breadth and depth is firſt to be dug; in which the foundations of the walls are laid, and built of ſuch a thickneſs, that they may eaſily ſuſtain the preſſure of the ground. On the inſide of the ſubſtruction, another foundation (G) is laid, at an ample diſtance inwardly from the exterior, ſo that the cohorts may be contained and exerciſed on the breadth of the bulwark. When theſe foundations are built thus diſtant from each other, then between them other tranſverſe walls[7*] (H, H,) are built, joining the exterior and interior foundations; being diſpoſed like the teeth of a comb, (I, I,) or in the manner of a ſaw (H, H,). For when they are ſo made, the great maſs of earth, being diſtributed into ſmall parts, cannot act with its united weight, or be able to force out the foundation walls.

BUT the materials of which theſe walls ſhould be built, cannot be determined; becauſe in all places we cannot have plenty of the beſt materials; where free-ſtone, flints, rubble, or bricks, burnt or unburnt, can be obtained, they muſt be uſed; for all places have not the advantage of Babylon, where there is an abundance of a liquid bitumen, which ſerves inſtead of lime and ſand, and the walls are built with burnt bricks. But all countries, or places, may have their peculiar advantages, and ſome kind of ſubſtances, with which, by theſe methods, the walls may be made durable, and without defect.

CHAPTER VI.

Of the Diviſion and Diſpoſition of the Works within the Walls.

THE walls being finiſhed, the next thing is the diviſion of the area within the walls, and the direction of the ſtreets and lanes to the proper regions of the heavens. Theſe will be properly directed, when thoſe winds are judiciouſly excluded from the ſtreets, which, if

(6*) Perault, Galiani, and Barbaro, have ſuppoſed this bulwark to be as high as the top of the wall. In the fore-mentioned example of the walls of Rome, ſome remains of ſuch a bulwark are ſtill to be ſeen, by which it appears, that it was raiſed only one ſtory high from the level of the city, in the manner of a terras. See H, G, Fig. I, and IV.

(7*) Adjoining to that part of the walls of Rome, where anciently ſtood the *Caſtro di Tiberio*, are yet to be ſeen the remains of walls diſpoſed like the tranſverſe walls here deſcribed, and were probably for the ſame purpoſe. Theſe tranſverſe walls, and part of the city wall adjoining, was rebuilt by Conſtantine, having been deſtroyed, together with the Caſtro, in the war between him and Maxentius.

cold, offend; if warm, corrupt; and if humid, are infectious; care therefore ſhould be taken to avoid this evil, which in many cities uſually happens. The town of Mitylene, in the iſland of Leſbos, is magnificently and elegantly built, but injudiciouſly diſpoſed. In this city, when Auſter blows, the inhabitants are ſick; when Corus, they have coughs; and when Septentrio, they are reſtored to health; but they cannot then remain in the lanes and ſtreets, on account of the ſeverity of the cold. Wind is only a current of air, flowing with uncertain motion; it ariſes from the action of heat upon moiſture; the violence of the heat forcing out the blaſts of air. That this is the fact, the braſs œolipyles make evident: for the latent operations of the heavens and nature may be diſcovered by the action of artificial machines. Theſe braſs œolipyles are hollow, and have a very narrow aperture, by which they are filled with water, and then placed on the fire. Before they become hot, they emit no effluvia; but as ſoon as the water begins to boil, they ſend forth a vehement blaſt; ſo that from this little eaſy experiment, we are able to judge of the cauſes of the great and mighty winds of heaven, and of the works of nature. If then a city is thus defended from the winds, it is not only rendered ſalutary to bodies in health, but alſo thoſe diſeaſes, which have ariſen from the malignity of other places, and which require the application of medicines, in this are ſoon removed by the means of the temperate ſtate of the air. The maladies which are cured with difficulty in the places abovementioned are, colds, the gout, coughs, pleuriſies, conſumptions, the emiſſion of blood, and ſuch like; which are not cured by diminution, but by augmentation. The reaſon theſe are with difficulty remedied, is, firſt, becauſe they are occaſioned by cold; and ſecondly, becauſe the diſeaſe having already impaired the ſtrength, the air agitated and attenuated by the motion of the winds, extracts the juices from the diſeaſed bodies, and thus renders them ſtill weaker. On the contrary, mild denſe air, not in frequent fluctuation, or redundance, nouriſhes and reſtores the members of thoſe, who are afflicted with ſuch infirmities.

Some will not allow that there are more than four winds; *ſolanus*, the equinoctial eaſt; *Auſter*, the ſouth; *Favonius*, the equinoctial weſt; and *Septentrionus*, the north. But there are found to be eight, by thoſe who have more attentively conſidered the ſubject. Of theſe Andronicus Cyrrheſtes is the chief; who, as an example, built at Athens, an octogonal tower of marble; and on the ſeveral ſides of the octogon carved the images of the ſeveral winds; diſpoſing each oppoſite to its reſpective region: on the top of the tower he erected a marble metæ, upon which he placed a triton of braſs, with his right hand extended, holding a wand, and ſo contrived that it was turned by the wind, always ſtanding oppoſite to the blaſt, and holding the wand over the image of the wind that then blew.[1*] There is therefore, between Solanus and Auſter, Eurus, or the winter eaſt; between Auſter and Favonius, Aphricus, or the winter weſt; between Favonius and Septentrionus, Caurus, which many call Corus; and between Septentrionus and Solanus, Aquilo; and in this manner they are

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(1*) In a French tranſlation of Vitruvius, by Jean Martin, in 1572, there is a deſign of this tower of Andronicus Cyrrheſtes; but ſince the publication of the ruins of Athens, by Mr. Stuart, we have the ſatisfaction of ſeeing the true and accurate draught of the original.

deſcribed, that the number and names of the ſeveral winds, and the parts from whence they blow, may be clearly underſtood.

Fig. I. and II. HAVING thus far premiſed, to diſcover their regions and ſources, this is the method. A marble compaſs exactly levelled, is placed in the middle of the city, or elſe the place itſelf ſo well poliſhed and levelled, as to render a compaſs unneceſſary. In the center of this place is fixed a metal gnomon to caſt a ſhadow, which the Greeks call *Sciatheras:* about the fifth hour[2*] in the forenoon, the extremity of the ſhadow of the gnomon

Fig. II. is obſerved, and marked with a point; then with the compaſſes extended ſo much as is equal to the length of the ſhadow of the gnomon, a line is circumſcribed round the center. In the afternoon alſo the encreaſe of the ſhadow is obſerved; and, when it touches the circular line, making the afternoon ſhadow equal to that of the forenoon, another point is made. From theſe two points deſcribing an interſection with the compaſſes, and from that interſection producing a line through the central point to the extremity, the ſouthern and northern regions are found. After this, taking with the compaſſes the ſixteenth part of the whole circumference of the circle, and placing the central foot in the meridian line, where it touches the circumference, marks are made therewith on the circle to the right and left, both on the ſouthern and northern ſide. Then from theſe four points, lines are drawn through the center, from extremity to extremity of the circumference, interſecting each other; thus the ſouth and north have each an eighth part aſſigned them; the remaining parts are equally diſtributed in the whole circumference, three to the right, and three to the left, according to the eight equal diviſions of the winds. This done, the directions of the ſtreets and lanes are diſpoſed in the angles, between every two winds; as, by this method, the habitations will be defended from their hurtful and offenſive violence. For when the ſtreets are diſpoſed directly oppoſite to the winds, the impetuous blaſts that frequently deſcend from the open ſpace of heaven, being confined in the narrow entrances of the ſtreets, fly through them with greater violence. But when the direction of the ſtreets are turned from the region of the winds, the blaſts, meeting with the angles of the iſlands of houſes,[3*] are broke, repulſed, and diſſipated.

PERHAPS, thoſe who know the many names of winds, will wonder that we have deſcribed no more than eight; but if they conſider that the circumference of the earth is, by the courſe of the ſun, and the ſhadow of equinoctial gnomons, ariſing from the inclination of the heavens, found by Eratoſthenes Cyreneus, according to mathematical rules and geometrical proceſs, to be two hundred and fifty two thouſand ſtadiæ; which make thirty-one million five hundred thouſand paces, and that the eighth part of this which is occupied by each wind, is three million nine hundred and thirty-ſeven thouſand five hundred paces, they will

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(2*) The Romans divided the day into twelve hours, beginning from ſun-riſe; as the night alſo conſiſted of twelve, beginning from ſun-ſet; the fifth hour, therefore, in the forenoon, muſt be about one hour before noon, or, as we expreſs it, eleven of the clock.

(3*) A pile of houſes, or buildings ſurrounded by ſtreets, was called an iſland. Suet. Life of Nero.

not wonder that one wind ranging in ſo great a ſpace, ſhould make various inflections, returns, and changes.

Auster, therefore, has on his right and left, Euronotus, and Altanus; Apricus has Libonotus, and Subveſperus; Favonius has Argeſtes, and at certain times Eteſiæ; Caurus has on either ſide Circius, and Corus; Septentrio has Thraſcias, and Gallicus; on the right and left of Aquilo, are Supernas, and Boreas; Solanus has Carbas, and at certain times Ornithiæ; Eurus, occupying the middle part, has on either ſide Cæcias, and Volturnus. There are many other names of winds derived from countries, rivers, or mountains; there are alſo the Auræ Matutinæ[4*], which the ſun, when it riſes from the ſubterranean regions, acting violently on the humid air, forces out from the vapours of the dawn; theſe [illegible] after the ſun is riſen, holding the part of the eaſtern winds, which for this reaſon appear to have been called Euros by the Greeks; as alſo, the morning, from theſe Auræ Matutinæ, they called Aurion. Some there are who deny that Eratoſthenes could compute the true meaſure of the earth; but ſuppoſing that to be the caſe, it does not invalidate our deſcription of the regions from whence the ſeveral winds ariſe, but only renders the juſt meaſure of the ſpace occupied by each wind, indeterminable, and uncertain.

To illuſtrate and facilitate the conception of theſe things, which are but briefly explained, two figures, or, as they are called by the Greeks, *Schematæ*, are placed at the end of the book: one is contrived to ſhew the regions, from whence the ſeveral winds ariſe; the other, to ſhew the manner of diſpoſing the lanes and ſtreets, ſo as to avoid their noxious blaſts.

Fig. II. The center of the level plain is ſhewn by the letter A, the ſhadow of the gnomon in the forenoon is at B. Extending the compaſſes to the mark of the ſhadow at B, deſcribe a circle. Let the gnomon remain, and wait while the ſhadow decreaſes, and again encreaſes, till the afternoon ſhadow is equal to that of the forenoon, and touches the line of the circle at C. Then extending the compaſſes from B to C, deſcribe an interſection D, and from that interſection, continue a line through the center to the letters E and F, at the extremities; this line will indicate the ſouthern and northern regions. Then with the compaſſes, taking the ſixteenth part of the whole circumference, and putting the central foot in the meridian line, where it touches the circumference at E, make marks to the right and left, where the letters G and H are placed. On the north ſide alſo, ſetting the central foot of the compaſſes in the circle, at the north line, where F ſtands, mark to the right and left, where the letters I and K are placed; draw lines from G to K, and from H to I, paſſing through the center. Thus the ſpace from G to H, will be the province of the wind Auſter, and of the ſouthern regions; as the ſpace from I to K, will be that of the northern. The remaining parts, three to the right, and three to the left, are equally divided; thoſe to the eaſt are marked with the letters L and M, and thoſe to the weſt with N and O; from M to O, and from L to N, lines are drawn, interſecting each other, and thus the circle will be divided into the eight equal ſpaces of the winds.

(4*) The morning breezes.

When it is thus deſcribed, theſe letters will ſtand at the ſeveral angles of the octogon, beginning at the meridian. Between Eurus and Auſter, the letter G; between Auſter and Aphricus, H; between Aphricus and Favonius, N; between Favonius and Caurus, O; between Caurus and Septentrio, K; between Septentrio and Aquilo, I; between Aquilo and Solanus, L; and between Solanus and Eurus, M. This being compleated, the gnomon is fixed between the angles of the octogon, and thus the IIX[5*] diviſions of the ſtreets and lanes are directed.

CHAPTER VII.

Of the Situation of the Public Buildings.

THE lanes and ſtreets being divided and diſpoſed, the ſituation of the ſquares, temples, forums, and the other public buildings, for the convenience and common uſe of the city, is next to be explained. If the city is near the ſea, the area deſigned for the forum ſhould be choſen near the port; but in an inland place, it ſhould be ſituated in the middle of the town (A). *Fig. I.* The temples of thoſe deities that are the tutular guardians of the city; as alſo thoſe of Jupiter, Juno, and Minerva; are to be ſituated in an elevated place, from whence the greater part of the city is diſcoverable; the temples of Mercury are placed in the forum, or in the emporium; as are thoſe of Iſis, and Serapis; thoſe of Apollo, and Bacchus, are near the theatre; that of Hercules, in ſuch cities as have no gymnaſiæ, nor amphitheatre,[1*] is to be built near the circus[2*]; that of Mars, without the city, but near the camp; that of Venus, alſo at the gate; for it is written in the doctrines of the Etruſcan Aruſpices, that[3*] the fanes of Venus, Vulcan, and Mars, ſhould be placed without the walls; that the youth and matrons may not be accuſtomed to the ſight of libidinous pleaſures; and

(5* IIX) Signifies two leſs than ten, that is eight.

(1*) It was the cuſtom of the Gladiators, when they were excuſed any farther performance in public, to hang up their weapons in the temple of Hercules; which, therefore, was uſually adjoining the place of performance; whether it was an amphitheatre, or circus.

(2*) Vitruvius here mentions amphitheatres, and circus's, but gives us no deſcription of either. See the Obſervations on the Life of Vitruvius.

(3*) Some of the tranſlators obſerve, that theſe rules for ſituating temples were not always obſerved; for Julius Cæſar built a temple to Venus, within the city, as Auguſtus alſo did to Mars; but in both theſe inſtances it may be conſidered that there were particular circumſtances, which might be the reaſon of deviating from the general cuſtom. Julius Cæſar boaſted of being deſcended from Venus; and Auguſtus erected this temple to Mars, as his patron and protector, in conſequence of his gaining the victory at the battle of Phillipæ. Theſe emperors, therefore, conſidering thoſe deities as their particular patrons, might be the reaſon of their giving them place within the city, contrary to the common uſage.

that of Vulcan being placed without the city, contributes to ſecure the buildings from fire, by calling out the religious rites and ſacrifices of that god. So when the fane of the god Mars is dedicated without the city, it is thought no civil diſſentions will happen therein, but it will be defended from its enemies, and the dangers of war. The temple of Ceres is alſo ſituated without the city, in a place which men do not frequent, except at the time of the ſacrifices; for with devotion, chaſtity, and purity of manners, this temple ſhould be approached. The other deities have their temples ſituated in places ſuitable to the forms of their ſacrifices.

But the rules for building ſacred edifices, and the ſymmetry of their plans, are given in the third and fourth books. For it appears to me proper, previouſly to treat in the ſecond book, of the materials neceſſary to be prepared for buildings, and of their qualities and uſes; and in the ſeveral books to explain the proportions of the ſeveral kinds of buildings, their ordination, and ſymmetry.

THE END OF THE FIRST BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE SECOND.

P R O E M.

AT the time that Alexander was conquering the world, Dinocrates,[1*] the architect, confiding in his knowledge and genius, and being desirous of obtaining the royal commendation, left Macedon, and repaired to the army. He carried with him letters from his relations and friends in his own country, to the nobles of the first rank, that he might thereby more easily gain access. Being favourably received, he requested to be immediately presented to Alexander; they gave him many promises, but made delays, pretending to wait till a proper opportunity should offer. Dinocrates, therefore, suspecting that he was derided, sought the remedy from himself. He was very large of stature, had an agreeable countenance, and a dignity in his form and deportment. Trusting to these gifts of nature, he clothed himself in the habit of an host, anointed his body with oil, crowned his head with boughs of poplar, put a lion's skin over his left shoulder, and holding one of the claws in his right hand, approached the tribunal where the king was administring justice. The novelty of the appearance attracting the notice of the people, occasioned Alexander also to see him, who, wondring at the sight, commanded way to be given, that he might approach. Alexander then demanded who he was; Dinocrates replied, I am a Macedonian architect, who comes to thee with ideas and designs, worthy of the greatness of thy fame; I have formed a design to cut mount Athos into the statue of a man, in whose left hand shall be a large city, and in his right, a bason, which shall receive all the rivers of the mountain, and again discharge them to the sea. Alexander delighted with the idea, immediately enquired, if the country adjacent would produce sufficient food for the sustenance of the inhabitants. When he understood that provision must be conveyed thither by sea, he replied; Dinocrates, I discern the excellence of thy design, and am pleased with it; but I consider, that whoever should establish a colony in such a place, would hereafter be justly blamed; for, as a new born

(1*) This architect is called by Pliny, B. 5. S. 11. *Dinochares*; and by Plutarch, in the Life of Alexander, *Stasicrates*; by some *Chinocrates*; and by others, *Chironocrates*.

infant cannot be nouriſhed, or gradually reared to the different ſtages of life, without the milk of the nurſe; ſo neither can a city be peopled, nor can it thrive, without fertile land and plenty of proviſion: however, as I approve the deſign, though I diſapprove the place, I will have thee attend me, that elſewhere I may employ thee. From that time, Dinocrates remained with the king, and attended him into Egypt. There Alexander, obſerving a ſpot which had an haven formed ſecure by nature, an excellent place for an emporium, the adjacent country through all Egypt being fruitful, and having the accommodation of the river Nile, ordered him to build the city now called from his name Alexandria. Thus, by the means of a graceful countenance and dignity of perſon, Dinocrates became eminent. But to me, O emperor, nature has not given greatneſs of ſtature; age has deformed my face, and infirmity has impaired my ſtrength; being therefore deprived of thoſe advantages, I endeavour, by the help of my knowledge and writings, to merit commendation.

As in the firſt book, I have ſpoken of the uſe of architecture, and the conſtituent parts of the art, the fortifications, and the diviſion of the area within the walls, it follows, as next in order, that the proportion and ſymmetry of temples, and public as well as private edifices, ought to be explained; but I judge it moſt proper to defer their deſcription, till I have previouſly diſcourſed on the ſeveral materials of which buildings are conſtructed; the rules for working them, their qualities, and the elements of which they are by nature conſtituted; and before I begin to explain the nature of theſe things, I ſhall ſpeak of the uſes of buildings, their origin, and how they were invented; alſo of the ancient ſtate of things; and whatſoever I have learnt from thoſe who have wrote on the origin of civil life, and uſeful inventions.

CHAP.

C H A P T E R I.

Of the Original of Buildings.

In ancient times, men, like wild beaſts, lived in foreſts, caves, and groves; feeding on wild food, and in that manner ſpending their time. In a certain place it once happened, that the trees, being agitated by tempeſtous winds, rubbing their branches one againſt another, took fire. Thoſe who were near the place, affrighted at the violent conflagration, fled; but afterward, as the flames abated, reſuming courage, they approached nearer, and finding the heat to be very comfortable to their bodies, they threw more wood into the decreaſing fire, and thus preſerved it. They then invited other men, making ſigns to them, to expreſs their opinion of its convenience. Men, thus aſſembled, made various ſounds with their voice; and by daily practice, ſome certain ſounds, by which they ſignified the things in frequent uſe, obtained, and became eſtabliſhed. From this caſual event language aroſe; and hence they began to converſe together. Fire, therefore, having thus occaſioned men to aſſemble, diſcourſe, and live together, by having attracted many to one place, they ſoon obſerved that they were by nature ſuperior to other animals; as not being prone, but walking erect, beholding the beauties of the earth and the heavens; alſo that, by means of hands and fingers, they could eaſily make any thing they pleaſed; they, therefore, to make themſelves coverings with the boughs of trees; ſome dug caves in Philoſophers. and others, in imitation of the neſts of ſwallows, with ſprigs and loam they might lie under; and by obſerving each other's work, and diſcover ſomething new, they by degrees improved and made ; and Heraclitus, of Epheſus, But men being of an imitative and docile nature, glorying reeks, *Scotinos*, fire; Democritus, ſhewing one another the houſes they had made, they, by ll indiſectible; others individual their faculties, became in time more ſkilful. air and earth, to water and fire. ; but nevertheleſs ſuppoſed individual

At firſt, to ſerve for the walls, they erected forke , when diſjoined from each other, are them, covered them with loam; others piled up dry ernally endure, and retain their ſolidity. with wood; and to avoid the rain and heat, they r the combination of theſe atoms, and are but finding that this roof could not reſiſt the winter think it not unneceſſary to treat of the at the top, plaiſtering it over with clay, and by tha uſed in buildings; that, when they are the origin of things was, as above written, ma ply them, but properly adapt the materials day, ſome foreign nations conſtruct their dwell Gaul, Spain, Luſitania, and Aquitain, they u in the kingdom of Pontus, where they aboun in ranks to the right and left, leaving as trees will permit; upon the ends, others ar of habitation in the middle; then, at t

O C H A P.

alternate beams; and thus the walls, by fixing other trees perpendicularly on thoſe below, may be raiſed to the height of towers. The interſtices which, on account of the coarſeneſs of the materials, remain, are ſtopped with chips and loam. The roof is alſo raiſed by beams laid acroſs from the extreme angles, gradually converging, and riſing from the four ſides to the middle point at the top, and then covered with boughs and loam. In this manner, the barbarians make the teſtudinal roofs of their towers. The Phrygians, who inhabit a champaign country, being deſtitute of timber, by reaſon of the want of foreſts, ſelect little natural hills, excavate them in the middle, dig an entrance, and widen the ſpace within as much as the nature of the place will permit; above, they fix ſtakes in a piramidal form, bind them together, and cover them with reeds, or ſtraw, heaping ther[illegible] piles of earth. This kind of covering renders them very warm in winter, and cool in ſummer; ſome alſo cover the roofs of their huts with the weeds of lakes; and thus in all nations and countries, the dwellings are formed upon ſimilar principles. At Marſeilles, we may obſerve the roofs without tiles, and covered with earth and ſtraw; at Athens, the Areopagus is at this day an example of the ancient roofs of loam; at the Capitol alſo, the houſe of Romulus,* in the ſacred citadel, may remind us of the ancient manner of covering our roofs with ſtraw. By theſe examples, therefore, we may be aſſured, that the firſt invention of building happened in the manner we have related; but at length, mankind by daily practice improved, and by repeatedly exerciſing their faculties and talents, arrived at the full knowledge of the art; thoſe who were moſt experienced profeſſing themſelves artificers. When, therefore, theſe things were thus far advanced, as Nature had not only [illegible] to mankind ſenſe in common with other animals, but had alſo furniſhed their minds [illegible]ement and foreſight, and had ſubjected other animals to their power, they, from [illegible]ding, gradually proceeded to other arts and ſciences, and from a ſavage and [illegible]ecame humane and civilized. Then, when their minds were thus [illegible]came more judicious by experience, and the advancement of the [illegible] they no longer built huts, but founded houſes, with walls [illegible]r other materials, covering the roofs with tiles. Hence by [illegible]n wandering, and uncertain opinion, arrived at the certain [illegible]y; obſerving alſo, that nature afforded a great variety of [illegible]uilding, they availed themſelves of that advantage, and [illegible]tended them to encreaſe the pleaſures and elegancies of [illegible]a able, treat of the proper application of the ſeveral [illegible]lities.

[illegible] of this book, and be of opinion that it ought to my reaſon for believing I have not erred in that

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ing of the city. This hut the Romans religiouſly obſerved never to repair with any other materials than reeds and ſtraw, in commemoration of their founder.

reſpect. As I propoſe writing a full Syſtem of Architecture, I judged it proper, in the firſt book, to mention the learning and ſcience with which that art ſhould ever be accompanied; to determine the extent of its nature, and of what parts it conſiſts; ſpecifying all the knowledge that is required in an architect: as, therefore, I have in the firſt book deſcribed the uſe of the art; I ought in this, to explain the qualities and uſes of the materials: for this book treats not only of the origin of architecture, but alſo of the inſtitution of buildings; from what cauſes they ſprang, and gradually attained their preſent perfection. This, therefore, is the proper place and order of this book.

Now, returning to our ſubject, to diſcourſe explicitly concerning the materials uſed in buildings, of the manner in which they are found to be generated by nature, and what elements are united in their compoſition. For no kind of materials, or ſubſtances, can grow, without the mixture of the elements. Neither can they be underſtood or explained according to the doctrine of phyſics, unleſs their cauſes are known, and the manner, and reaſon why they ſo exiſt, is demonſtrated.

CHAPTER II.

Of the Principles of Things, according to the Opinion of Philoſophers.

THALES believed water to be the principle of all things; and Heraclitus, of Epheſus, who, from the obſcurity of his writings, is called by the Greeks, *Scotinos*, fire; Democritus, who is followed by Epicurus, atoms; which we call indiſectible; others individual corpuſcles; for the philoſophy of Pythagoras adds air and earth, to water and fire. Democritus, therefore, did not properly deſcribe things; but nevertheleſs ſuppoſed individual corpuſcles, as appears by his own words, and which, when disjoined from each other, are incapable of injury, decay, or diviſion; but muſt eternally endure, and retain their ſolidity. As, therefore, all things ſeem to be conſtituted, by the combination of theſe atoms, and are divided into an infinite number of different kinds, I think it not unneceſſary to treat of the varieties and divers properties of thoſe which are uſed in buildings; that, when they are known, thoſe who intend to build may not miſapply them, but properly adapt the materials of buildings to their ſeveral uſes.

CHAPTER III.

Of Bricks.

I SHALL firſt ſpeak of bricks, and the earth of which they ſhould be made. They ſhould not be made of ſandy, ſtoney, or gravely loam; for ſuch kinds of earth, in the firſt place, render them heavy; and, ſecondly, upon being wetted with the rain, after they are [illegible] the wall, they ſwell and diſſolve; and the ſtraw which is put in them, does not adhere on account of their roughneſs. Bricks ſhould be made of earth that is white and chalky, or red, or having a maſculine[1*] large ſand; for theſe kinds being light and ſtrong, are not weighty in working, and are laid with facility. They ſhould alſo be made in the ſpring, or autumn, as being the beſt time of drying; for thoſe made in the ſummer, are not found, on account of the intenſe heat of the ſun, which parches the outſide, before the inſide is ſufficiently dry; which afterward drying in the building, cauſes them to ſhrink and break others which were dry; by that means rendering the ſtructure infirm, and full of fractures. They are beſt when made two years before they are uſed; for they cannot be ſufficiently dry in leſs time. If they are uſed when newly made, and moiſt, the plaiſter work which is laid on them, remaining firm and ſtiff, and they ſhrinking, and conſequently not preſerving the ſame height with the incruſtation, it is by ſuch contraction looſened and ſeparated; by this means the plaiſtering breaks, and falls from the building; for, on account of its thinneſs, it cannot ſtand of itſelf; and the walls themſelves are ſometimes damaged thereby. At Utica, therefore, the laws allow no bricks to be uſed before they have lain to dry five years, as muſt be proved to the magiſtrates, by whoſe authority they may then be uſed for the building of walls.

Fig. V. THERE are three ſorts of bricks; one which the Greeks call *Didoron*, which are ſuch as we uſe; they are a foot long, and half a foot broad. The other two ſorts are uſed in the buildings of the Greeks; one of which they call *Pentadoron*, and the other *Tetradoron*; for the Greeks call the palm *Doron*, becauſe a gift which is always preſented with the palm of the hand, is in Greek called *Doron*; thoſe bricks, therefore, which have on every ſide five palms, are called *Pentadoron*, and thoſe which have four, *Tetradoron*; in public works they uſe the former; and in private, the latter. Of theſe bricks

Fig. VIII. they alſo make half bricks; and in working, the whole bricks (a) are placed in one courſe, and the half bricks (b) in the other. So that when both parts are built to a level, they appear to be laid in the walls with alternate faces outward, the middle of the bricks being diſpoſed perpendicularly over the joints, giving ſtrength, and not

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(1*) It is not known what kind of ſand Vitruvius means by the words *Maſculo Sabulone*. Several of the commentators have given their conjectures concerning it; but none appear ſatisfactory, or worth mentioning.

an unhandſome appearance to both parts.* At Calentum, in the farther Spain; at Marſeilles, in Gaul; and at Pitane, in Aſia; there are bricks which, when made and dried, will ſwim, if thrown into the water. The reaſon they ſwim is, becauſe the earth of which they are made, is pumicoſious, and replete with air, not receiving or imbibing the water; being therefore light and porous, and not ſuffering the water to penetrate into its ſubſtance; however large the maſs may be, the bricks, in the ſame manner as pumice ſtones, are ſuſtained on the water. The Calentines have therefore a great advantage; for theſe bricks are not weighty in the building, and when once made, cannot be impaired by the weather.

CHAPTER IV.

Of Sand.

IN all cementitious buildings, the firſt thing to be conſidered is the ſand; it ſhould be ſuch as will mix well in the mortar, and have in it no mixture of earth. The kinds of pit-ſand are, the black, white, red, and carbuncle; of theſe, ſuch as crackles upon being rubbed in the hand, are the beſt; for ſuch as are earthy have not that aſperity; ſuch alſo as, being thrown on a white garment, do not ſoil it, or leave any dirt thereon, are good. But in places where there are no pits, ſand muſt be procured by ſifting of gravel, or taken from rivers, as well as from the ſea-ſhore; but this latter is not good for building, becauſe it dries with difficulty, and walls wherein it is uſed cannot be built without intermiſſions of reſt, nor will they bear the preſſure of arched floors; alſo in buildings where the walls are plaiſtered, the ſalts exuding from ſea-ſand, diſſolves the plaiſtering; whereas buildings in which pit-ſand is uſed, quickly dry, the incruſtation ſtands firm, and the walls will ſuſtain

(2*) Vitruvius does not mention the thickneſs of the bricks; the ancients made their bricks very thin, almoſt like tiles, as appears by their remains. The thickneſs, therefore, might be an eſtabliſhed meaſure, or dependent on the ſuperficial magnitude of the brick.

The bricks, *Tetradoron*, and *Pentadoron*, uſed by the Greeks, were ſquare, having, as Vitruvius ſays, every ſide equal, each ſide of the former meaſuring four palms, and of the latter, five. The *Didoron* bricks, which the Romans uſed, were oblong, being a foot long, and half a foot broad; that is, four palms long, and two broad, which is exactly equal to half a *Tetradoron* brick. As, therefore, the Greeks made half bricks of each of the ſorts which they uſed; the half *Tetradoron* bricks of the Greeks were exactly ſimilar to the *Didoron* bricks of the Romans, and might be laid in the ſame manner, and make juſt the ſame appearance in the work.

Barbaro, Alberti, and ſome others, have ſuppoſed theſe half bricks were made by dividing the whole brick diagonally, ſo that they become triangular; of which kind ſome are ſtill to be ſeen in the remains of the walls of Rome, in that part particularly which was built by the emperor Aurelian; but it is evident that Vitruvius does not here mean that triangular ſort, but a quadrangular kind, made by dividing the whole brick quadrilaterally; for he ſpeaks of their appearing to be laid in the wall with alternate faces outward; thereby implying that the faces were of different dimenſions, which is not the caſe of the two ſides of ſuch triangular bricks. The diagonal ſide is indeed of a different dimenſion from the other two; but it cannot be probably ſuppoſed that Vitruvius means that ſide to be uſed alternately with the others; its meaſure being ſo diſproportionate and incongruous to the ſquare ſides, that they can never be made to agree together in any regular order.

the weight of the arches. Sand ſhould be uſed freſh from the pit; for if it lays long expoſed, it is, by the action of the ſun, moon, and rain, diluted, weakened, and made earthy; and, if then uſed in any ſtructure, it will not conſolidate the materials, which therefore ſeparate and fall, rendering the walls unable to ſuſtain their burthen. But though pit-ſand is ſo well adapted for building of walls, it is not proper for incruſtations; for, on account of its fatneſs, which cauſes a violent fermentation when mixed with the lime and ſtraw, it will not dry without cracking. But river ſand, by reaſon of its meagreneſs, being beaten with ſtaves like ſigninum,[1*] makes the plaiſtering ſtrong and durable.

CHAPTER V.

Of Lime.

SAND having been ſufficiently explained, lime muſt alſo be properly conſidered; it ſhould be burnt from white ſtone, or flint, of which the thick and hard ſort are more proper for building walls, as thoſe which are porous are for plaiſtering. When the lime is burnt, the ingredients are thus to be mixed; with three parts of pit-ſand, one part of lime is to be mingled, but if river or ſea-ſand is uſed, two parts of ſand, with one of lime, muſt be united; for in theſe proportions the mortar will have a proper conſiſtence: if bricks, or tyles, pounded and ſifted, be joined with river or pit-ſand, to the quantity of a third part, it will make the mortar ſtronger, and fitter for uſe. The reaſon that lime, when ſaturated with water and ſand, conſolidates the materials, ſeems to be this: ſtones, as well as all other ſubſtances, are compounded of the elements; thoſe which have moſt air, are tender; thoſe which have moſt water, are, by reaſon of their humidity, tenacious; thoſe which have moſt earth, are hard; and thoſe which have moſt fire, brittle. If theſe ſtones were only pounded into minute pieces, and mixed with the ſand without being burnt, they would not indurate, or unite; but when they are caſt in the furnace, and there penetrated by the violent heat of the fire, they loſe their former ſolidity; and being calcined and deprived of their ſtrength, they are left exhauſted, and full of pores. The water and air, therefore, which are in the ſubſtance of the ſtones, being thus diſcharged and expelled, and the latent heat only remaining, upon being repleniſhed with water, which repels the fire, they recover their vigour, and the water entering the vacuities, occaſions a fermentation; the ſubſtance of the lime is thus refrigerated, and the ſuperabundant heat ejected. But the ſtones, when

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(1*) Signinum, is, according to Pliny, Book 35, C. 12, a kind of mortar made with lime, mixed with broken tyles, or earthen veſſels, beaten very ſmall. Vitruvius himſelf, at Book 8, Chap. 7, ſays, it is made with pure rough ſand, and lime made of flint-ſtones. Galiani writes, ſand, lime, and flint-ſtones; but I think he miſtakes the ſenſe of the paſſage.

taken out of the furnace will not be of the ſame weight they were before they were burnt; for, if weighed, though the magnitude will remain the ſame, they will be found to be decreaſed in weight, by the evaporation of the humidity, about a third part. When, therefore, their pores and cavities are again ſaturated with ſand, they unite and dry together, and by that means conſolidate the materials.

CHAPTER VI.

Of the Earth of Pozzuoli.

THIS is a kind of earth that naturally produces admirable effects: it grows in the territory of Baiæ, and in the municipal lands about the mountain Veſuvius: being mixed with lime and bricks, it not only renders common buildings exceedingly ſtrong, but alſo ſtrengthens moles which are built in the ſea; for it preſently ſets, and becomes hard, under the water. The reaſon of this appears to be, that as under all this mountain and country adjacent there are great fires of burning ſulphur, alum, or bitumen, as may be known by the many hot ſprings thereabout, the flaming vapours ariſing from theſe internal fires, pervading and burning in the interſtices, render the earth light, and the ſand that grows there dry, and without moiſture. When, therefore, theſe three things, all ariſing from a ſimilar cauſe, viz. the intenſe heat of fire, are blended together, upon receiving water they ſpeedily unite, and, by means of the humidity, ſoon become hard and ſolid; nor can the waves, or utmoſt violence of the water, ſeparate them. That there is fire in thoſe places, is indicated by theſe circumſtances: in the mountains of Cumæ and Baiæ, ſweating caves are dug, from the bottom of which iſſues a fervid vapour, which by means of its heat perforates the earth, and ſprings forth in thoſe places; making excellent and uſeful ſudatories. It is moreover reported, that in former times the fire increaſed and ſuperabounded under the mountain Veſuvius, from whence a flaming matter was ejected around the country, which matter is now called the pompeianian ſponge, or pumice. This appears to be formed of various kinds of ſtones burnt, and reduced to that ſtate and quality; for ſuch ſpongy kind of ſtones grow in no other places, except about mount Ætna, the Myſian hills, named by the Greeks *Catacecaumenoi*, and in ſuch kind of places. Since, therefore, ſprings of hot water

(1*) This earth of Pozzuoli, is now called Pozzolana ſand; it was firſt found in the neighbourhood of Pozzuoli, anciently called Puteoli, from whence it derived its ancient name Pulvere Puteolano; it is a kind of red earth very much reſembling pounded bricks, or tyles; and, indeed, I have reaſon to believe, from my own experience, as well as from the accounts I have received from others who have made the trial, that pounded bricks or tiles, as Vitruvius preſcribes in the former chapter, being mixed with the lime and ſand, and well beaten, will in a great meaſure anſwer the end of the Pozzolano ſand.

are found in theſe places, fervid vapours ariſe in the caves of the mountains, and we know by tradition that theſe ſame countries were formerly overſpread with fire, it cannot be doubted that the ſand and earth are deprived of their moiſture by the heat of fire, in the ſame manner as lime is in the furnace. Theſe different and diſſimilar things, therefore, being effected by the ſame acting power, receive a ſimilar heat and drineſs of nature; and upon being ſuddenly ſaturated with water, the latent heat occaſioning a violent fermentation in the common maſs, cauſes them to unite, and ſpeedily acquire a conſolidating property.

One queſtion remains; viz. that ſince there are in Tuſcany many hot-ſprings, how happens it that the earth which thus cements ſtructures under the water, is not to be found there alſo? As this queſtion requires an anſwer, the explanation muſt not be omitted. In all countries, the earth is not of the ſame nature, nor do the ſame kind of ſtones grow; in ſome places they are earthy, in others ſandy, or gritty; in ſome, gravelly; and in others, of different and various qualities, according to the various properties of the earth: as, for example, it may be obſerved, that the countries of Italy and Tuſcany, which are ſurrounded by the Appennine mountains, have no want of ſand-pits near every part; but beyond the Appenines, on the ſide next the Adriatic ſea, none are to be found; alſo in Achaia, Aſia, and beyond ſea, in general, they are unknown. So likewiſe, in all places where ſprings of hot water ariſe, the ſame properties may not concur, for they all proceed from the natural conſtitution of things; no ways depending on the will of men, but being fortuitouſly generated. Wherever, therefore, the mountains are not earthy, but are of a petrifiable kind of ſubſtance, the heat of the fire iſſuing forth through the interſtices, endurates the parts, burning whatever is ſoft and inflamable, and leaving only what is hard and incombuſtible. As, therefore, in the Campania, the burnt earth becomes Pozzuoli ſand; ſo in Tuſcany, the ſoil is by heat turned to the carbuncle kind of ſand; both are excellent for building, but one is moſt proper for ſtructures on land, and the other for moles, and thoſe which are built in the ſea; the Tuſcan ſoil is by nature ſofter than gravel, and harder than earth; wherefore, by the violent heat of the ſubterraneous vapours, which exhale in ſome places, the ſpecies of ſand, called carbuncle, is there generated.

CHAPTER VII.

Of Stone Quarries.

Having ſpoken of the ſeveral kinds of ſand and lime, and alſo of their qualities, it follows next to treat of the quarries, from whence the hewn, as well as the rubble ſtones, for edifices, are extracted; theſe are found to be different and various in their nature; for ſome are ſoft, as the red kind near the city, and thoſe of Pallienſis, Fidenæ and Albanæ; others are moderately hard, as the Tiburtine, Amiternine and Soractine; and ſome are very hard,

as are thoſe of flint; there are alſo divers other kinds; as, in the Campania, the red and black gravel; in Umbria, Picæno, and Venice, the white ſtone, which may even be cut with a ſaw, like wood; but all the ſoft kinds, though they afford this conveniency, that the ſtones when extracted, are wrought with facility, and if ſituated under ſhelter, will anſwer the end; yet, if they are left uncovered, and expoſed to the weather, they will be ruptured and diſſolved by the froſt and rain; alſo, if they are near the ſea-coaſt, they will be corroded by the ſalts; neither will they bear heat.

On the contrary, the Tibertine ſtones, and thoſe of the ſame kind, will bear all the injuries of the weather, as well as the burthen laid upon them, but are not proof againſt fire; for, if they are heated by it, they ſplit, and ſhiver to pieces; for they are naturally tempered of a ſmall portion of water and earth, and much air and fire. When, therefore, they are expoſed to the action of fire, the internal vapours being rarified and expelled, the fire eaſily enters the vacuities, burning, and giving their ſubſtance a ſimilar degree of heat; but there are many ſtone quarries, on the confines of Tarquinium, called Anitianæ, of the colour of the Albanian, the pits laying chiefly about the Vulſinian lake[1*], in the prefecture of the Statonienſi, which are of an excellent quality, for neither froſt nor fire can hurt them; and they endure, and remain ſound to a great age; for they are naturally tempered of an equal portion of air and fire, a moderate quantity of water, and much earth; ſo that, being ſolid and compact, they ſuffer neither from the weather, nor the violence of fire. This is particularly proved by the monuments, near the town of Ferentum, which are built of theſe ſtones, and in which there are large ſtatues excellently wrought, as well as ſmaller figures, flowers, and Acanthus leaves, elegantly carved; which, though old, appear as perfect as if lately made; the braſs workers alſo, prepare their molds for founding, from the ſtone of this quarry, and find it exceeding ſerviceable: if it was near the city, it ought to be made uſe of in all works[2*].

But as their vicinity makes it neceſſary to uſe the quarries of red ſtone, and thoſe of Pallienſis, which are near the city, it is proper to mention how theſe materials ſhould be prepared.

When an edifice is intended to be built, they ſhould be extracted from the quarry two years before they are to be uſed; not in winter, but in ſummer; and muſt be left laying in uncovered places; thoſe which, in the two years, have been injured by the weather, are uſed in the foundation; the others, which are not damaged, being thus proved by nature, will alſo remain unhurt, when they are laid in the ſuperſtructure. This method is to be obſerved not only in ſtructures of hewn ſtone, but alſo in all cementitious buildings[3*].

(1*) Now called *Lago Bolſeno*.

(2*) Tacitus informs us that Nero, after the fire which happened in his reign, ordered the houſes to be rebuilt with Albian and Gabian ſtone, which would endure the heat of fire unhurt.

(3*) Cementitious buildings are thoſe wherein rubble ſtones or bricks, are uſed.

CHAPTER VIII.

Of the ſeveral Sorts of Walls.

THE ſorts of walls are, the reticulated,[1*] (FIG. VIII.) which is now generally uſed; and the antient, which is alſo called the incertain; (FIG. IX.) Of theſe two the reticulated is the handſomeſt, but the joints are ſo ordered, that in all parts, the courſes have an infirm poſition; whereas, in the incertain, the materials reſt firmly one upon the other, and are interwoven together; ſo that they are much ſtronger than the reticulated, though not ſo handſome;[2*] both ſorts are formed of very ſmall pieces that the walls being ſaturated with mortar, may endure the longer; for the ſtones being of a porous and ſpongy nature, abſorb the moiſture from the mortar; and when there is an abundance of mortar, the wall having more humidity, will not ſo ſoon decay, but will on that account be rendered more durable; for, as ſoon as the humidity is extracted from the mortar by the ſuction of the ſtones, then the lime and ſand ſeparating, the cement is diſſolved, and the mortar no longer uniting the materials, the walls ſoon become ruinous. This may be obſerved in ſome tombs near the city, which are built with marble, or hewn ſtone, and the internal parts rammed with rubble ſtones; the mortar being by length of time drained of its humidity by the ſuction of the ſtones, and the union of the joints being diſſolved, they ſeparate, and fall to ruin.

Fig. IX. To avoid this error, the middle ſpace muſt be ſtrengthened with abutments of the red hewn ſtone, or bricks, or common flints, built in walls two feet thick, and bound to the fronts with cramps of iron fixed with lead; for the work being thus built in a

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(1*) In ſeveral parts of Italy there are walls of the reticulated kind yet ſtanding, that were built in the time of the firſt Roman emperors; which is a ſufficient proof of their ſtrength and durability.

(2*) In the incertain ſort of walls, I underſtand that the courſes were always level, but that the upright joints were not ranged regularly, or perpendicular to each other in the alternate courſes, nor in any other reſpect correſpondently; but were diſpoſed uncertainly, according as the accidental ſize, &c. of the ſtone, or brick, occaſioned. Thus our bricks are commonly arranged in ordinary walls, in which all that is regarded, is, that the upright joints in two adjoining courſes do not coincide. Perault believing that the word *incertum*, ſhould be read *inſertum*, thinks, that the ſtones were arranged in level courſes, and correſponding upright joints, and that this ſort was called *inſertum*, only from the ſtones being inſerted between each other. But I cannot be of this opinion, becauſe in that caſe, this ſort would be as handſome as the reticulated ſort, or more ſo; being the ſame manner in which Vitruvius, at the third chapter foregoing, ſays, the Roman and Greek bricks were diſpoſed, and which he commends as being agreeable.

Nor can I think with Galiani, and ſome others, that in the incertain ſort, the ſtones themſelves were irregular, and were alſo placed diſorderly, without any regard to horizontal courſes, or perpendicular joints; becauſe that arrangement would be leſs firm than the reticulated kind, which is directly contrary to the words of Vitruvius.

The manner I have conjectured is, at leaſt, ſo far right, that it agrees with the words of the text, in being more firm, though leſs handſome than the reticulated, and alſo makes the word *imbricatus* agree with the ſenſe of the paſſage, without reading it *implicatus*, as ſome have ſuppoſed it ſhould be read; for it implies, that in the incertain manner the ſtones are laid in the ſame order as tyles are uſually arranged, which is exactly the fact, according to my ſuppoſition.

regular manner, and not laid in promiſcuous heaps, will remain without defect; and being by the orderly arrangement of the courſes and joints firmly united and bound together, it will not be liable to fractures, nor will the abutments ſuffer it to fall to decay. For this reaſon, the walls of the Greeks are not to be deſpiſed; for though they do not uſe ſmooth, or poliſhed materials, yet where they diſcontinue[3*] the ſquare ſtones, they lay the flints or common hard ſtones that they uſe, in the ſame manner as bricks are generally laid, binding the courſes together with alternate joints, and thus make their works ſtrong and durable.

These walls they build in two manners; one is called *Iſodomum*, (Fig. x.) the other *Pſeudiſodomum*, (Fig. xi.) *Iſodomum* is, when all the courſes are of an equal thickneſs; and *Pſeudiſodomum*, when they are unequal: both theſe ſorts are firm; firſt, becauſe the ſtones themſelves are of a compact and ſolid nature, and do not abſorb the moiſture from the mortar, but preſerve its humidity to a great age; and, ſecondly, being ſituated in regular and level courſes, the mortar is prevented from falling; and the whole thickneſs of the wall being united, it endures perpetually.

Fig. XII. Another ſort is that which they call *Emplecton*, which is alſo uſed by our villagers. The faces of the ſtones in this kind, are ſmooth; the reſt is left as it grows in the quarry, being ſecured with alternate joints and mortar; but our artificers quickly raiſing a ſhell, which ſerves for the faces of the wall, fill the middle with rubble and mortar; the walls, therefore, conſiſt of three coats, two being the faces, and one the rubble core in the middle. But the Greeks do not build in that manner; they not only build the

Fig. XIII. facing courſes regularly, but alſo uſe alternate joints thorough the whole thickneſs, not ramming the middle with rubble, but building it the ſame as the face, and of one united coat conſtruct the wall; beſide this, they diſpoſe ſingle pieces (A) which they call *Diatonos*, in the thickneſs of the wall, extending from one face to the other, which bind and exceedingly ſtrengthen the walls. Thoſe, therefore, who would build works of long duration, muſt attend to theſe rules, and make uſe of ſuch methods of building; for the ſmooth poliſh, and beautiful appearance of the ſtones, will not prevent the wall from being ruined by age.[4*] For this reaſon, when valuations are made of

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(3*) Galiani tranſlates this paſſage thus: *nelle fabriche che non richiedono pietre quadrate, adoprano Selce:* in buildings which do not require ſquared ſtones, the Greeks uſe flints, &c. I underſtand it differently; viz. that, in the middle part of the walls, where the ſquare facing ſtones were diſcontinued, the Greeks uſed flints, &c. For it is plain that, Vitruvius here compares the Greek walls with the Roman, only in that ſingle circumſtance of which he is treating; viz. the manner of working the middle part of the wall; ſaying, that though the Greeks did not uſe ſmooth facing ſtones, yet, the internal part of their walls, where the ſquare ſtones were omitted, and flints, &c. were uſed, they built in a better manner than the Romans did, not laying them in promiſcuous heaps, but interweaving them together in the manner of bricks. See Fig. X. and XI. The words of the text are, *ſed cum diſceſſerunt a quadrato, ponunt de ſilice, ſeu de lapide duro ordinarium & ita uti lateritia ſtruentes aligant eorum alternis coriis coagmenta.*

(4*) The Roman *Emplecton*, Fig. XII. had a core of rubble ſtones in the middle, thrown in promiſcuouſly; but the Greek *Emplecton*, Fig. XIII. was wrought throughout the whole thickneſs with ſtones, in the ſame manner as the facings, or fronts. The Roman *Emplecton* differed alſo from the Greek *Iſodomum*, and *Pſeudiſodomum*; in that theſe latter, though they had a core of rubble ſtones in the middle, yet, thoſe rubble ſtones were interwoven together in the manner of bricks, and not laid promiſcuouſly, as in the Roman walls. The Roman reticulated kind, I conclude, was the ſame throughout the whole thickneſs, as Vitruvius ſays nothing to the contrary, and ſpeaks of no core in the middle.

common buildings,[5*] the value is not fixed at the price for which they might be built; but finding from the records, their time of letting, an eightieth part of their original value is deducted for every year elapsed, and the remaining sum is adjudged to be the value of the building; it being the received opinion, that they cannot endure more than eighty years.

But as to buildings of brick, provided they stand perpendicularly, nothing is deducted; they are always estimated at the sum for which they might have been first built; in many cities, therefore, the public, as well as private buildings, and even palaces, are constructed with bricks; as, the walls of Athens, which look toward the mounts Hymettus and Pentelensis: the walls of the cells of the temples of Jupiter and of Hercules, are also built of bricks, the surrounding columns and epistylium being of stone; the ancient walls of Arezzo, in Italy, excellently wrought: the house built by the Attalic kings, at Tralles, which is always given for the habitation of those who bear the office of priests of the city: the paintings which were brought from Lacedæmon, were cut from walls of bricks, and conveyed in cases of wood, to ornament the Comitium, in the edileship of Varro and Murena: the house of Crœsus, which the citizens of Sardis converted into a college for the retirement of the aged: the mausoleum of the most potent king of Hallicarnassus, in which, though the ornaments were all of Proconnesian marble, the walls were built of bricks, which remain to this time exceedingly substantial; and the incrustation appears as polished and shining as glass. Nor was it to avoid expence that this king used bricks; for, as he commanded all Caria, his revenue was immense, and superfluous; but it was the result of his judgement and knowledge in building, as may from the following instance be concluded.

He was born at Mylasso, but observing Hallicarnassus to be a place fortified by nature, well adapted for commerce, and having a commodious harbour, he there established his residence. This place is in the form of a theatre; the forum is situated at the bottom, near the port. At the top, in the middle of the curve, is formed an area, or square, of ample dimensions, in the midst of which stands the mausoleum, a building so excellent, that it is numbered amongst the seven wonders of the world. In the middle of the citadel above, is the temple of Mars, having the colossal statue which they call Acrolithon, made by the hand of the noble Telochares,[6*] or, as some think, by Timotheus. The temple of Venus and Mercury is at the extremity of the right horn of the curve, near the fountain of Salmacis; of which, those who drink, according to a vulgar notion, become amorous: but the origin of this false report, which has spread over the whole world, must be related. It owed its rise to no property in the water producing effeminacy or unchastity; but to its transparency and

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(5*) *Paries* may signify any structure; either a house, or a single wall; I have supposed it to signify the former, in this place; because it appears to me undoubtedly to be the meaning of Vitruvius; the rather, as he presently after mentions the time of letting, which cannot be supposed to allude to a single wall, but must refer to some kind of habitation, or dwelling.

This is one reason why I cannot follow the example of Galiani, in translating the word *communis* exterior. See Note 7, Chap. I. Book I.

(6*) Vitruvius names one Leochares, in the preface of his seventh Book; and Pliny, Chap. V. Book XXXVI. mentions Leochares, a sculptor, who flourished under the reign of king Mausolus; from whence it is thought, that Telochares, here named, was the same person; the different spelling being very likely owing to the mistake of the copyists.

agreeable taſte; for, when Melas, and Arivanias, conducted to this place a colony from Argos and Trœzen, they expelled the ſavage Carians and Leleges; who flying to the mountains, there aſſembled together, making excurſions, and continually plundering and waſting the country. Some time after, one of the colony, invited by the goodneſs of the water, ſettled a tavern near this fountain, for the purpoſe of gain, furniſhing it with all neceſſaries; this inticed thither the barbarians, who reſorting thither ſingly, and frequently meeting there in numbers, by degrees changed their rude and ferocious manners, for the cuſtoms and urbanity of the Greeks; and were thus voluntarily ſubjected. Hence the report aroſe; not from any effect of the water, but from its being the means of civilizing the minds of the barbarians. I now quit this ſubject, to return to the deſcription of the city, in which I was engaged.

As the temple of Venus, and the above mentioned fountain, ſtands on the right horn, ſo on the left, ſtands the royal palace, which king Mauſolus there judiciouſly ſituated. For on its right ſide, it commands the view of the forum, the port, and the whole compaſs of the city; on its left there is a ſecret port, ſo concealed by the mountains, that none can ſee or know what is there tranſacted; and the king himſelf could, from his palace, privately give his commands to his ſeamen and ſoldiers. After the death of Mauſolus, when his wife Arthemiſia reigned, the Rhodians, filled with indignation that all the cities of Caria ſhould be governed by a woman, diſpatched a powerful fleet to take poſſeſſion of the kingdom; Arthemiſia, hearing this, prepared a private ſquadron, well furniſhed with mariners and ſoldiers, and concealed them in this ſecret port; ordering the reſt of the citizens to guard the walls. When the pompous fleet of the Rhodians appeared before the greater port, ſhe commanded thoſe who guarded the walls, to ſeem to give them encouragement, and pretend that they would ſurrender the town; the deluded Rhodians having entered within the walls, and left their navy weakly defended, Arthemiſia, unexpectedly opened a canal that had a communication with the ſea, brought the ſquadron out of the ſecret port into the greater, and the Rhodian fleet being abandoned by the mariners and ſoldiers, and left defenceleſs, ſhe drew it off to ſea. The Rhodians, therefore, having no place of retreat, and being ſurrounded on all ſides, were ſlain in the aforementioned forum. Arthemiſia then embarked her rowers and mariners in the Rhodian veſſels, and ordered them to ſail to Rhodes: the Rhodians ſeeing their veſſels approach, decorated with laurel, believed their fellow citizens were returned victorious, and received the enemy. By this ſtratagem, Arthemiſia ſurpriſed Rhodes; ſlew the principal men, and then raiſed a trophy of her victory in the midſt of the city; making two ſtatues of braſs, one repreſenting herſelf, and the other, the city of Rhodes, held by her in ſubjection. In after times, the Rhodians (as their religion forbad the removal of a conſecrated monument) erected a high wall around it, in the Greek manner, that the trophy might not be ſeen, and ordered it to be called *Abaton*.

As, therefore, ſuch great and potent princes did not diſdain to erect walls of bricks, whoſe revenues and ſpoils would have enabled them, to uſe not only rough, or hewn ſtones, but even marble; I think, edifices conſtructed of bricks, are not to be diſapproved, provided they are well executed. But bricks cannot be uſed by the Romans within the city; the

reaſon of which, I muſt not omit to explain. The laws permit no walls which are built in public places, to be of a greater thickneſs than one foot and a half; and to ſave room, other walls are made of the ſame thickneſs; but brick walls of a foot and a half thick, unleſs they contain the length of two or three bricks in that thickneſs, cannot ſuſtain more than one ſtory[7*]; yet, the dignity of the city, and the multitude of citizens, requiring innumerable habitations, and, as the area of the city cannot contain ſo great a number as inhabit it; to remedy the deficiency, the height of buildings is encreaſed. To this end, the walls are raiſed with hewn ſtone, teſtaceous ſubſtances[8*], or rubble, and built many ſtories high; thus making convenient apartments, both for repaſt and proſpect; by means, therefore, of galleries, and multiplying the ſtories, the habitations are, without inconvenience, made ſufficient, and ſuitable for the Roman people. Thus the reaſon is given, ~~wherefore~~ on account of the limited ſpace of the city, it is neceſſary to prohibit walls of brick; whereas, without the city, buildings of brick may be ſo executed, as to endure firm to a great age.

The tops of walls, juſt under the tiles, ſhould be built of teſtaceous materials, for about the height of a foot and a half; and ſhould have a projecting cornice, by which means the uſual defect will be avoided; for, if the tiles of the roof happen to be broke, or blown off by the wind, and the rain water penetrates, this teſtaceous covering will prevent it from injuring the bricks, and the projecting cornice ſhelters, and by that means preſerves, the walls from damage. Whether teſtaceous ſubſtances are defective or not, cannot at firſt be known; but if they remain ſound, after having laid in the roof, and endured a winter and ſummer, they are good; for ſuch as have not been made of good loam, or have not been ſufficiently burnt, on being thus tried by the rain and froſt, diſcover their imperfection. Thoſe, therefore, that will not anſwer their purpoſe in the roof, cannot be firm enough to bear the weight of the walls; wherefore, walls built of old tiles, from a roof, will be the moſt ſubſtantial.

As to the hurdle walls, I wiſh they had never been thought on; for, however convenient they may be, on account of expedition, or for ſaving ground, they are, nevertheleſs, a great

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(7*) To underſtand this paſſage, it is neceſſary to be here recollected, that the Roman bricks, called *Didoron*, were a foot and a half long, and a foot broad; conſequently, if they had uſed theſe bricks in walls of a foot and a half thick, ſuch walls being but one brick in thickneſs, muſt have been very weak; becauſe the bricks could not have been interwoven and united together, or, as our workmen expreſs it, they could have had no bond. Unleſs, therefore, (as Vitruvius intimates) their bricks had been made of ſuch a ſize, that the length of two or three of them might have been contained in the thickneſs of the wall, the work could not have been ſufficiently ſtrong to have bore many ſtories.

Our laws have alſo limited the thickneſs of party walls to a foot and a half; not indeed with a ſimilar intention, to prevent our making them too thick, which is not our propenſity; but on the contrary, to prevent our making them too thin. Yet, we find our walls of a foot and a half thick, ſtrong enough to bear ſeveral ſtories; the reaſon of which is, that our bricks are ſo ſmall, that the length of two of them may be contained in the thickneſs of the wall, and, therefore, they may be properly interwoven and bonded together.

(8*) It appears evident, that by teſtaceous ſubſtances, Vitruvius means tiles, or ſome ſort of burnt earth, and not any kind of ſhells, as ſome have imagined; for, a little after, he ſays, it cannot at firſt be known whether they have been made of proper loam, or have been well burnt; and alſo ſpeaks of walls built of tiles.

The whole of this chapter is very ſimilar to the 14th chapter of the 35th book of Pliny, and it is very probable that one was copied from the other. See the Obſervations on the Life of Vitruvius.

and public evil; being as liable to take fire as faggots, purpoſely prepared; it is better to be at the coſt of brick walls, than to ſave that expence by living in danger. In thoſe which are plaiſtered, crevices are left perpendicularly and tranſverſely; for, upon receiving the plaiſter, its humidity cauſes them to ſwell, and, as it dries, they contract; by which they break and deſtroy the texture of the incruſtation; but, as ſome perſons, on account of diſpatch, or poverty, or to ſave ground, may be obliged to uſe them, they ſhould build them in this manner. A footing ſhould be built ſo high that the hurdles may be raiſed from the gravel and pavement; for, if they are ſunk in the ground, they ſoon become rotten, and by ſettling downward, break the face of the plaiſtering.

HAVING treated of walls in general, and the preparation and properties of the materials of which they are conſtructed, in the beſt manner I have been able, I ſhall now ſpeak of the floors, the materials of which they are formed, and the manner of preparing them, ſo that they may endure unimpaired a great length of time.

CHAPTER IX.

Of Timber.

TIMBER may be felled, from the beginning of autumn, to the time when the wind Favonius begins to blow[1*]; for, in the ſpring, all trees become pregnant, and put forth their annual fruit in the branches, according to their ſeveral natures; when, therefore, by the influence of the ſeaſon, they are porous and humid, they are then rendered weak and uſeleſs. The bodies of women, when they have conceived, are not judged to be in health till after their delivery; neither are ſlaves, when pregnant, deemed ſound; becauſe in bodies that are breeding, the fœtus draws all the nouriſhment of the food to itſelf; and, as it encreaſes, and approaches nearer to the time of delivery, the leſs ſound the generating body becomes; but when the fœtus is delivered, the nutriment which it before attracted to itſelf, is received by the exhauſted and open veſſels of the progenetrix, which abſorbing the juices, the body is reſtored to its former natural ſanity. For the ſame reaſon, at the ſeaſon of autumn, when the fruits are ripe, and the branches grow flaccid, the roots receiving in themſelves the juices of the earth, the trees are recovered and reſtored again to their former vigour; for they are compreſſed and conſolidated by the force of the winter air: if, therefore, the timber is felled according to theſe rules, and at the time above written, it will be found the moſt proper ſeaſon.

(1*) The wind Favonius was ſuppoſed to begin to blow about the eighth day of February. Pliny, book 16, chap. 25.

TREES are to be felled in this manner: they ſhould be cut half through their thickneſs to the pith, and ſo left, that by diſcharging the ſap they may grow dry; for the emiſſion of the uſeleſs juices from the pith, will prevent the timber from being corrupted by the retention of the putrid matter. Then when the tree is thoroughly dry, and drops no longer, it muſt be felled; and being thus prepared, it will be fit for uſe. It may be obſerved that ſhrubs, at the proper time, become perforated at bottom; and by means of thoſe perforations, pour out from the pith their ſuperfluous and vitiated juices, and thus drying, render themſelves durable. In thoſe which have not this efflux, the ſtagnating humours putrefy, and render them unſound and periſhable. If, therefore, trees are found to be preſerved by drying while they are ſtanding and vegetating, without doubt they ſhould be ſo treated when they are to be felled for timber; for being prepared in that manner, they will remain in the building ſerviceable to a great age.

TREES are of various kinds, and have different properties; as, the oak, the elm, the poplar, the cypreſs, the fir, &c. which are the kinds chiefly uſed in building. The oak has not the qualities of the fir, nor the cypreſs of the elm; nor are any of the others alike in their qualities; but each kind has a peculiar nature and mixture of the elements, and one or other will anſwer all purpoſes. In the firſt place, the fir has much air and fire, and little water and earth; being therefore conſtituted of things of a light nature, the wood is not ponderous, is naturally rigid, and will not eaſily bend under its burthen, but will remain in the flooring, ſtraight, and inflexible: this wood, however, having much heat, is apt to breed worms, which deſtroy itſelf. It alſo eaſily takes fire; for being light, open, and aireal, it readily kindles, and emits a violent flame; that part of it which is neareſt the earth before it is felled, receiving moſt moiſture on account of its proximity to the root, is rendered knotleſs, and moſt humid: on the contrary, the upper part, which, by reaſon of the fervent heat, is extended in the air in knotty branches, being cut at the height of twenty feet, and hewn ſmooth, is, from its knotty hardneſs, called *Fuſterna*; but the bottom part, when it is hewn and ſeparated into four quarters, the ſappy part being rejected, is reſerved for the internal work, and called *Sapinus*.[2*]

THE oak, having a ſuperabundance of the element of earth, and very little water, air, and fire, when uſed in works in the ground, will endure for ever; for being impervious and cloſe, it, on account of its compactneſs, will admit no moiſture into its ſubſtance; but reſiſting and ſhunning the humidity, warps, and ſplits the work in which it is uſed. The *Eſculus*,[3*] which is equally compounded of all the elements, is of great uſe in building; but if placed in water, the humidity entering its pores, and expelling the air and fire, makes it ſoon decay.

(2*) See Note 13. Chap. II. Book I.

(3*) I have mentioned this tree by its Latin name; for it is doubtful, what tree is to be underſtood by it; ſome ſuppoſing it to be a beach, and ſome a ſpecies of oak, called the holm; but this latter is more generally ſuppoſed to be the Cerrus, which Vitruvius names afterward.

Pliny, in his Natural Hiſtory, book 16. chap. 5. ſeems to ſpeak of the *Eſculus* as well as the *Cerrus*, as different ſpecies of oaks.

The holm, the cork, and the beech, have an equal mixture of water, fire, and earth, but abound in air; being therefore porous, and eaſily permitting fluids to penetrate them, they ſoon periſh.

The white and black poplar, the willow, the lime, and the agnus caſtus, are replete with fire and air, have a moderate portion of water, and very little earth; they are therefore of a light temperature, and have a toughneſs which is found exceeding ſerviceable; for not being hardened by a large mixture of earth, and by reaſon of their rarity, being white, they are very manageable, and proper for carving.

The alder, which grows near the banks of rivers, and is a wood not much uſed, has ſome excellent qualities; for being compounded of much air and fire, and a little portion of earth and water, its ſubſtance is not overcharged with moiſture. Piles, therefore, of this wood, being drove in the foundation of edifices which are erected in marſhy places, there imbibing the humid element of which their ſubſtance leaſt partakes, will endure eternally, and ſupport the moſt ponderous ſtructures. This wood, therefore, which out of the earth can endure but a ſhort time, will, if buried in a watery ſoil, laſt for ever. This may be chiefly obſerved at Ravenna, for there all buildings, as well public as private, have theſe kind of piles in their foundations.

The elm, and the aſh, having much water, little air and fire, and a moderate quantity of earth, are, by reaſon of their abundant humidity, too pliable, and eaſily bend under their burden; but when they become dry by age, or have arrived at that ſtate of perfection in growing, the moiſture within them being inactive and ſtagnant, they then become more tough, and from their flexible quality are very uſeful and ſtrong in all caſes where joinings are neceſſary.

The maple likewiſe containing much air and water, and little fire and earth, is not brittle, but has a uſeful pliability. The Greeks, therefore, who make the yokes of oxen, called *zyga*, of this wood, name it *Zygian*.

Nor leſs to be valued are the cypreſs and pine, which have an abundance of water, and an equal mixture of the other elements; being therefore replete with moiſture, if they are uſed when green, they are apt to ſplit; but when old they remain long without defect; for the juice which is in their ſubſtance, has a bitter ſavour, and by its acrimony, ſuffers no worms, or any deſtructive vermin, to enter; for which reaſon, buildings conſtructed of theſe kinds of timber, endure an immenſe time.

The cedar and juniper have the ſame virtues and uſes; and, as from the cypreſs and pine comes reſin, ſo from the cedar flows the oil which is called *Cedrium*; with which books, and other things, being anointed, are preſerved from moths and worms; the leafage of theſe trees is like that of the cypreſs; and the fibres are ſtraight. The ſtatue in the temple of Diana, at Epheſus, is made of this wood; ſo alſo, on account of its durability, are the

Lacunariæ[4*] of that, and of many other magnificent temples. Theſe trees grow chiefly in Crete, Africa, and in ſome parts of Syria.

The larch tree, which is unknown, except to the inhabitants about the banks of the Po, and the ſhore of the Adriatic ſea, is not only preſerved from the rot, and worms, by an exceſſive bitter juice, but is alſo ſecure from fire; for it will not flame, but will only conſume to a calx, as ſtones do in the furnace, by the means of other wood; nor will it even then burn, and become as a coal, but ſlowly, and after a long time will be conſumed. The reaſon is, becauſe it has in its ſubſtance very little of the elements of fire and air; but of water and earth, it is replete and full; and has no pores by which the fire may enter to diſſolve its texture. This wood will not ſoon decay, and, on account of its ponderoſity, water cannot ſuſtain it; ſo that when it is to be tranſported, it is placed either in veſſels, or on rafts of fir. The firſt diſcovery of this timber happened thus: when the army of the deified Cæſar was near the Alps, he commanded the inhabitants to ſhew him a ſafe paſſage, and to conduct him over thoſe mountains; there was a fortified caſtle called Larignum, and thoſe that were therein confiding in its natural ſtrength, refuſed to obey his command: the emperor, therefore, ordered it to be attacked. Before the gate of the caſtle was a tower, conſtructed like a funeral pile, with beams of this wood placed alternately tranſverſe, from the top of which they annoyed the aſſailants with ſtakes and ſtones; when it was obſerved that they had no other weapons than wooden darts, and that they could not throw them far from the walls, by reaſon of their weight, orders were given to approach with faggots and burning faſcines, and pile them againſt the tower. The ſoldiers quickly obeyed, and the flames from the faggots aſcending to a great height round the tower, made it believed that the whole maſs was conſumed; but when the fire abated, and was extinguiſhed, the tower appeared unhurt. Cæſar, ſtruck with admiration, then ordered it to be aſſaulted with the miſſile engines; upon which, the country people being affrighted, ſurrendered. It was then demanded of them, where this timber, which remained unhurt by fire, grew; and they ſhewed theſe trees, of which in that place there is a great abundance; from the caſtle of Larignum, therefore, this tree takes its name. This timber is brought by the river Po to Ravenna, to ſupply the colonies of Fano, Peſaro, Ancona, and the other municipal cities in that diſtrict: if it could conveniently be brought to Rome, it would be of great utility in building; for, in caſe it could not be uſed in all parts, at leaſt it might be diſpoſed in the projectures about the eaves of the inſular buildings, and thereby greatly contribute to ſecure them from the danger of fire; for this wood will neither flame, nor will it burn like a coal. The leaves of this tree are like thoſe of the pine; the timber is large; and for inſide work, not leſs manageable than the Sappinus; it yields a liquid reſin of the colour of Athenian honey, by which the phthiſic is cured.

Thus I have explained the ſeveral kinds of timber, and their properties; I ſhall next give the reaſon why that kind of fir, which at Rome is called Supernas, is worſe than

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(4*) The *Lacunariæ* are the pannels or coffers in the cielings, or in the ſoffites of the cornices, &c.

that called Infernas, which is exceeding durable, and ſhall explain the good and bad qualities they derive from the nature of the places where they grow, that they may be fully underſtood.

CHAPTER X.

Of the Firs called Supernas, and Infernas.

THE Appenine mountains riſing from the Tyrrhene ſea, have their origin in the Alps, and in the extreme parts of Hetruria.(1*) Theſe mountains bend like a yoke, the middle of the curve almoſt touching the ſhore of the Adriatic ſea, from whence they take their courſe toward the Straights. The nether ſide of theſe mountains, which looks toward the country of Hetruria, and the Campania, is of a warm nature; the ſun inceſſantly ſhining on it the whole day; but the farther ſide, which declines toward the Adriatic ſea, being turned to the northern regions, remains continually obſcure, and in ſhadow. The trees, therefore, which grow on that ſide, being nouriſhed by a humid ſoil, not only encreaſe to a great magnitude, but, from the abundance of moiſture, have their pores ſaturated therewith; and when felled and hewn ſmooth, loſing their vegetative property, and the toughneſs of their fibres altering as they dry, they, by reaſon of their poroſity, become weak and periſhing, ſo that they will not endure long; but thoſe which grow in places expoſed to the heat of the ſun, being leſs porous, and their juices being extracted, are rendered more durable; for the ſun not only abſorbs the moiſture from the earth, but exhales it from the trees alſo; thoſe, therefore, which grow in the ſunny parts, having their fibres cloſe and compact, and not being rendered porous by too much humidity, will, when hewn into timber, remain long

(1*) Now called Tuſcany, or rather the preſent Tuſcany is part of Hetruria.

This paſſage has been differently rendered by the tranſlators. They have been induced to think that the text erroneouſly deſcribes the extent of the Appenines, to be from the Alps to that extreme of Tuſcany next Rome, thereby implying that they extended no farther; whereas, it is well known that they extend from the Alps to the extremity of Italy, far beyond the confines of Tuſcany, or limits of ancient Hetruria.

The text ſays, the Appenines have their origin in the Alps, and in the extreme parts of Hetruria; meaning (as I underſtand it) that extremity of Hetruria which is toward the Alps, not the other extremity toward Rome; Vitruvius, in that place, ſpeaking only of their riſe, not of their extent. In the next paſſage he ſpeaks of their extent, ſaying, they advance toward the Adriatic ſea, and from thence bend their courſe toward the Straights; meaning, without doubt, the Straights of Meſſina, at the extremity of Italy, to which they really do extend, and where they terminate. So that the deſcription, according to the text, is perfectly juſt. The words of the text are: *montis Appennini primæ radices ab Tyrrheno mari in Alpes & in extremas Hetruriæ regiones oriuntur, ejus verum montis jugum ſe circumagens media curvatura prope tangens oras maris Adriatici pertingit circuitionibus contra Fretum.* By the words, *in extremas Hetruriæ*, has been generally underſtood, that extremity of Hetruria next Rome; which has been the ſource of the miſtake. This is an unimportant matter; but as it has been generally miſapprehended, and ſuppoſed to be an erroneous deſcription, I thought proper to mention it. See Perault's Note on this Paſſage.

ſerviceable. This is the reaſon, therefore, that the fir called Infernas, which is brought from the ſunny ſide, is preferable to that called Supernas, which comes from the ſhady ſide.

THUS much have I treated, as well as I have been able, of the materials neceſſary for the conſtruction of buildings; of the elements of which they are obſerved to be conſtituted, and alſo of the ſeveral properties they poſſeſs, that they may not be unknown to thoſe who build. Thoſe, therefore, who follow theſe precepts, will, by properly adapting the ſeveral kinds of materials to their uſes, be deemed the moſt ſkilful. The preparatives being now fully explained, I ſhall, in the following books, treat of buildings; and, firſtly, as due order requires, of the ſymmetry and proportion of the ſacred temples of the immortal Gods.

THE END OF THE SECOND BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE THIRD.

PROEM.

APOLLO of Delphos, by the voice of the prieſteſs, pronounced Socrates to be the wiſeſt of men. This wiſe and judicious man is reported to have ſaid, that the human breaſt ſhould have been open as a window, that the thoughts might not have been concealed, but have been expoſed to obſervation; ſo, following his idea, I wiſh that all nature had been conſtituted open and apparent; that not only the virtues and vices of mankind might have been readily diſcerned, but alſo, that the knowledge of all ſciences might have been evident to the ſenſes; that no erroneous opinions might have prevailed, and all arts and erudition have been truly and perfectly comprehended. But as things are not thus conſtituted, and it is not poſſible to diſcover the capacity and knowledge which lays concealed in the minds of men; it therefore often happens that artiſts of great abilities, who are not rich, or have not become known by long buſineſs, or by recommendation, and are alſo unſkilled in popular eloquence, cannot obtain by their works, the reputation of poſſeſſing ſo much merit, as thoſe who are eminent are believed to poſſeſs.

THIS we may chiefly obſerve among the ancient ſtatuaries and painters, who have gained commendation, and whoſe names will remain famous to the lateſt poſterity; as Myron, Polycletus, Phydias, Lycippus, and others who have acquired reputation by their art; for they have obtained it by executing works for great cities, kings, or noble perſons; while others, who have not been leſs ingenious and capable, and have performed excellent works for private and unknown perſons, have obtained no fame; not for want of induſtry, or capacity, but of good fortune: ſuch are Hellas, of Athens; Chion, of Corinth; Myagrus, of Phocis; Pharax, of Epheſus; Bedas, of Byzantium; and many others. Alſo among the painters, Ariſtomenes, of Thaſos; Polycles, of Atramitene; Nicomachus, and others,

who were neither deficient in induſtry, the knowledge of their art, or ingenuity; but either poverty, ill fortune, or being overcome in their purſuits by opponents, have impeded their ſucceſs. Nor is it wonderful that, on account of people's ignorance of the arts, the meritorious ſhould be neglected; but it raiſes our indignation when the intereſt of friends influences the judgment to a falſe preference. Wherefore, as Socrates ſaid, if all thoughts, opinions, and knowledge, became viſible and evident, neither favour nor intereſt would avail; but whoſoever by real application and ſtudy became moſt capable, would be voluntarily employed. However, as things are not thus open and apparent, and I obſerve that the ignorant receive encouragement more frequently than the ſkilful, I judge it not proper to contend with the illiterate; but rather, by publiſhing theſe precepts, to manifeſt the uſefulneſs of our art.*

In the firſt book, therefore, O emperor, I have written of the art, its uſes, and of the ſciences an architect ought to underſtand; adding the reaſons why he ſhould be ſo qualified; I have alſo regulated the parts, and determined the limits of architecture: then, becauſe it was moſt neceſſary, and firſt to be done, I have treated of the rules for chuſing healthy ſituations; the manner of building the fortifications; of the ſeveral winds, and from what regions they blow; explaining the ſame by draughts; and alſo, of the commodious diſtribution of the ſtreets and lanes within the walls; of all which the firſt book conſiſts. In the ſecond, I have written of the materials, their uſes in buildings, and the properties they naturally poſſeſs. Now, in the third, I ſhall ſpeak of the ſacred temples of the immortal Gods, and of the manner in which they ought to be conſtructed.

(*) Vitruvius's deſcription of his own time ſeems very juſtly to agree with the preſent. It is now uſual for ignorance and intereſt to prevail over merit; it indeed ſeems to be the natural effect of things; for merit is naturally diffident and reſerved, as ignorance (having nothing elſe to depend on) is neceſſarily aſſuming, and forward; and the latter qualities muſt generally prevail; becauſe the majority of people cannot have ſo much knowledge in every art as is requiſite to enable them to diſtinguiſh merit from incapacity; for which reaſon they are obliged to form their opinion, on the pretences, appearances, or public fame of perſons, or elſe are governed in their choice by intereſt and prejudice. If merit is preferred for its own ſake, it is as much owing to the knowledge of the judges, as to the ſkill of the artiſt; for how ſhould merit be preferred, unleſs it is perceived; and how ſhould it be perceived, unleſs the judges have a ſufficient knowledge of the art, to enable them to diſtinguiſh it?

CHAP.

CHAPTER I.

Of the Compoſition and Symmetry of Temples.

THE compoſition of temples, is governed by the laws of ſymmetry; which an architect ought well to [illegible] this ariſes from proportion, which is called by the Greeks, *Analogia*. Proportion is the correſpondence of the meaſures of all the parts of a work, and of the whole configuration, from which correſpondence, ſymmetry is produced; for a building cannot be well compoſed without the rules of ſymmetry and proportion; nor unleſs the members, as in a well formed human body, have a perfect agreement.[1*] For nature has ſo compoſed the human body, that the face from the chin to the roots of the hair at the top of the forehead, is the tenth part of the whole height; and the hand, from the joint to the extremity of the middle finger, is the ſame; the head, from the chin to the crown, is an eighth part; and it is the ſame from the bottom of the neck. From the ſummit of the breaſts, to the roots of the hairs, is a ſixth[2*]; and to the top of the head it is a fourth; ſo alſo from the bottom of the chin to the bottom of the noſtrils, is a third part of the height of the face; the noſe, from the bottom of the noſtrils, to the middle of the eye-brows, is the ſame; and from thence, to the roots of the hairs where the forehead ends, it is alſo a third part. The foot is a ſixth part of the height of the body; the arm[3*] is a fourth; the cheſt[4*] is likewiſe a fourth; the reſt of the members have their meaſures alſo proportional; this the ancient painters and ſtatuaries ſtrictly obſerved, and thereby gained univerſal applauſe. In like manner, the meaſures of the ſeveral parts of ſacred edifices ſhould have due correſpondence to the magnitude of the whole. The central point of the body is the navel: for if a man was laid ſupine with his arms and legs extended, and a circle was drawn round him, the central foot of the compaſſes being placed over his navel, the extremities of his fingers and toes would touch the circumferent line; and in the ſame manner as the body is adapted to

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(1*) Vitruvius has alſo defined ſymmetry and proportion in the ſecond chapter of the firſt book; but his definitions here, as well as there, ſeem equally confuſed and unintelligible.

(2*) This cannot mean to the root of the hairs above the forehead; for, if it is a fourth from the breaſt to the top of the head, it muſt be above a ſixth from the breaſt to the top of the forehead. If it may be underſtood to the roots of the hair at the lower part of the face adjoining the ears, or at the neck, it will exactly agree; the diſtance of thoſe parts, from the breaſts, being exactly a ſixth part of the whole height of the body.

(3*) This means the cubitus, or arm, from the elbow to the end of the fingers.

(4*) The text has it *pectus*, which I have tranſlated cheſt, rather than breaſt; believing Vitruvius ſignifies by that word, the trunk of the body, from the breaſt to the lower part of the belly; and which is a fourth part of the height of the body. For ſhould I ſuppoſe that Vitruvius meant the breadth acroſs the breaſt, as Galiani and others have done, it would be irreconcileable with the true proportion of the body: I am the rather inclined to be of this opinion, as Vitruvius has already deſcribed the upper part of the body above the breaſt; and therefore may very naturally be ſuppoſed to ſpeak now of the part below it.

the circle, it will alſo be found to agree with the ſquare; for, if the meaſure from the bottom of the feet to the top of the head is taken, and applied to the arms extended, it will be found that the breadth is equal to the height, the ſame as in the area of a ſquare.

Since, therefore, nature has ſo compoſed the human body, that the members are proportionate and conſentaneous to the whole figure, with reaſon the ancients have determined, that in all perfect works, the ſeveral members muſt be exactly proportional to the whole object; and, as in all works they preſcribe this method, ſo more eſpecially in the temples of the Gods, in which the excellencies and faults remain for ever. The meaſures, which are neceſſarily uſed in all works, are alſo derived from the members of the human body; as, the digit,[5*] the palm, the foot, and the cubit; these are divided into the perfect number, which the Greeks call *Telion*; for the ancients believed the perfect number to be that which is called *ten*; becauſe *ten* is the number of the fingers of the hands: from the digit, the palm, and from the palm, the foot was invented.

Also as nature has formed ten fingers to the hands, Plato eſteemed that number perfect; decads being produced by unities, which the Greeks call *Monades*. Advancing to eleven, or twelve, the numbers become imperfect, till they arrive at the next decad; for unities are the conſtituents of that number.

The mathematicians, on the contrary, argue that the perfect number is that called *ſix*; becauſe, according to their principles, it has ſix proportional diviſions. Thus, one is the Sextant ($\frac{1}{6}$); two, is the Trient ($\frac{1}{3}$); three is the Semis ($\frac{1}{2}$); four, the Bes ($\frac{2}{3}$); which is called *Dimoiron*; five, the Quintarius ($\frac{5}{6}$), called *Pentamoiron*; ſix, the number perfect. Then counting upward, and adding one ſixth, it is called *Ephecton*; eight, becauſe it is the addition of a third, is the Tertiarius, which is called *Epititros*; nine, being the addition of the half, is the Seſquialter, called *Emiolios*; ten, is the Beſalter, ealled *Epidimoiron*; the number eleven, being the addition of five, is the Quintarium Alterum, called *Epipentamoiron*; and twelve, becauſe it is formed of twice the ſimple number, is called *Dyplaſiona*.

Moreover, the foot of a man is the ſixth part of his height; becauſe, therefore, ſix times the meaſure of the foot terminates the height of the body, they eſtabliſh it as the perfect number; obſerving alſo that the cubit, (or arm,) contains ſix palms, (or hands,) and twenty-four digits, (or fingers.)[6*] As the cubit contains ſix palms, for that reaſon, it ſeems the cities

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(5*) The digit is a finger's breadth, as the palm is a hand's breadth.

(6*) If the beauty, or agreeable effect reſulting from the compoſition, or configuration of a work, principally depends on the proportion and ſymmetry of its parts, (as in my opinion it does) and if any one number can be ſaid to be better adapted to produce that proportion and ſymmetry than another, it muſt be that whoſe integral parts are beſt ſuited to all the poſſible, or at leaſt, proper proportions that may be uſed in any work. The number ſix has in this reſpect the preference of any other; not from any ſuppoſitions, or imaginary virtue, but for uſeful and poſitive power; for this number being formed by the union of the radix's of the

of Greece divided their drachm into ſix parts; for their drachm contains ſix equal pieces of braſs coin, like the Aſſe; which they call Oboli, and each Obolus containing four Dichalcæ, or, as ſome call them, Trichalcæ, make twenty-four in a drachm; anſwering to the digits in a cubit; but we originally choſe the former number *ten*; and conſtituted the Denarius, *Denos æreos*, of ten braſs Aſſi[7*]; which piece of money to this day retains the name of Denarius. The *Seſtertius* alſo, which is a quarter part of a Denarius, was ſo called, becauſe it contained two whole Aſſi, and half of the third Aſſe. But afterward, conſidering that both the numbers ſix and ten were perfect, we joined them together, and ſo made the moſt perfect number, *ſixteen*; from hence aroſe the diviſions of the foot; for, deducting two palms from the cubit, there remains four; and, as each palm contains four digits, the foot, of courſe contains ſixteen; and juſt ſo many braſs Aſſi are in the Denarius. Thus, all meaſures were derived from the members of the human body; and as the ſeveral members thereof have a proportional relation to the whole, ſo in the temples of the immortal Gods we ſhould endeavour, that the parts of the work may be ſo regulated, that their proportion and ſymmetry, ſeparately, and unitedly, may be comformable and correſpondent.

The principles of temples, which determine their aſpect and figure, are theſe; firſt, In Antis, which by the Greeks is called *Naos en paraſtaſin*; then Prostylos, Amphiprostylos, Peripteros, Pseudodipteros, Dipteros, and Hypætros[8*]; by which principles, the formations of temples are diſtinguiſhed.

Fig. XIV. A temple is, In Antis, when it has Antæ (D), in the front of the walls, which circumclude the ceil[9*] (A); in the middle between the Antæ, two

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duple and triple numbers, viz. 2 and 3, (which being multiplied together make ſix). It naturally becomes moſt eaſily reſolvable into every other number, whether duple or triple; and conſequently is moſt capable of agreeing with all proportions of what kind ſoever.

It may alſo be obſerved, that the ratio of all the muſical concords are within the compaſs of a ſixth; and the ratio, ariſing from the multiplication of all their numerators and denominators, is in its loweſt term, as one, to ſix.

Neither can the ſenſes diſtinguiſh with facility a diviſion leſs than a ſixth; the 8th, 10th, and 12th, are eaſy to diſtinguiſh, only by reaſon of their compariſon with the 4th, 5th, and 6th.

Proportion is diſtinguiſhed into arithmetical, geometrical, and harmonical; the firſt is, when a ſeries of numbers in progreſſion, have the ſame real difference; as 2, 4, 6, 8, 10, 12, &c. The ſecond is when they have the ſame proportional differences; as 2, 4, 8, 16, 32, &c. The third is, when in three numbers, the firſt is to the third, as the difference between the firſt and ſecond is to the difference between the ſecond and third; as 6, 4, 3. Or, in four numbers, when the 1ſt is to the 4th, as the difference between the 1ſt and 2d is to the difference between the 3d and 4th; as, 4, 5, 6, 8. This latter kind of proportion, is that which the concords of muſic bear to each other; as for example, 6, (the fundamental) is to 3, (the octave) as the difference between 6 and 4 (the fifth) is to the difference between 4 and 3.

Barbaro, in his notes, has launched out exceſſively in his remarks on the ſeveral kinds and variations of proportions; but I believe the hints I have here given, and the notes at Chap. I. Book I. will be found ſufficient for an architect's attention and uſe.

(7*) The Denarius was originally divided into ten aſſi; but in the 485th year of Rome, an alteration took place, from which time it contained ſixteen aſſi.

(8*) Moſt of theſe names are derived from *Stylos*, column; and *Pteron*, wing. Thus *Proſtylos*, ſignifies having columns in front; *Amphiproſtylos*, columns in both fronts; *Peri-pteros*, winged round, or having columns all round; *Di pteros*, double winged; and *Pſeudo-dipteros*, falſe double winged; *Hypethros*, ſignifies uncovered; and *In Antis*, having antæ, or pilaſters.

(9*) The cell is the internal part, or chamber of the temple A, Fig. XIV, XVIII, &c.

columns (F); and the Faſtigium[10*] (E), placed above in the proportion which will be deſcribed in this book. An example of this is at the three temples of Fortune,[11*] in that of the three which is next the gate Collina.

Fig. XIV. Prostylos has all things the ſame as *In Antis*; but has alſo two columns (C), oppoſite the two angular Antæ (D), and the Epiſtylium[12*] (I), above, in the ſame manner as *In Antis*; as alſo on the returns to the right and left.[13*] An example of this, is in the temple of Jupiter, and of Faunus,[14*] on the iſland in the Tiber.

Fig. XV. Amphiprostylos, is the ſame as *Proſtylos*; but has alſo columns, and a Faſtigium in the Poſticus (H), in the ſame manner.

Fig. XVIII. Peripteros has, in the front, and in the Poſticus, ſix columns; and in the flanks, eleven, including thoſe at the angles; which columns are ſo diſpoſed, that the diſtance of an intercolumn is left all round between the walls, and the extreme range of columns, forming a walk about the cell of the temple. Thus is the temple of Jupiter Stator, in the Porticus of Metellus,[15*] which was deſigned by Hermodus;[16*] and the Marian[17*] temple of Honour and Virtue, built by Mutius, without a Poſticus.

(10*) *Faſtigium* is the word Vitruvius uſes for the pediment, or angle of the roof. See E, in the Elevations of Fig. XIV, &c.

(11*) This alludes to a place in Rome where there were formerly three temples of Fortune.

(12*) Epiſtylium, in this place ſignifies the whole entablature, I, I, Fig. XIV.

(13*) The manner of empreſſion here uſed, makes it doubtful whether the epiſtylium only, or the columns alſo, returned on the angles. The tranſlators have underſtood it differently; but the latter manner is ſo impure and ſo foreign to the practice of the ancients, that I cannot heſitate in rejecting it.

(14*) Titus Livius, L. 34, S. 53, mentions the temples of Jupiter and of Faunus, as two diſtinct temples. Barbaro alſo deſcribes that of Jupiter to be near the temple of Eſculapius; and that of Faunus, at another part of the iſland; of this latter he ſays, "a few ruins were to be ſeen in his "time, but which would ſoon be deſtroyed, as the Tiber "continually waſhed away that point of the iſland on which "they ſtood.

(15*) Livy mentions two temples of Jupiter Stator; one vowed by Romulus, the other by the conſul Poſthumus Megellus. Tacitus counts that built by Romulus, among thoſe buildings which were deſtroyed by the fire in Nero's reign. The tranſlators have rendered this paſſage in ſuch a manner, as to give us to underſtand that the porticus of Metellus was in the temple of Jupiter Stator, inſtead of the latter being in the former; and that the former was the example Vitruvius inſtances, inſtead of the latter. It was the cuſtom of the ancients to build ſpacious walks and porticos about the temples, as we may learn from Chap. IX. of Book V. and from the fragments of the plan of Rome, now preſerved in the Capitol: but it is without all authority, or probability, to ſuppoſe that the porticus of Metellus ſhould have been incloſed within the temple, and that, ſo ſituated, it ſhould have been a proper example of peripteral temples.

(16*) Some will have it that this ſhould be read Hermodorus, becauſe it is well known that there was an architect of that name, he being mentioned by ſundry authors; whereas an architect of the name of Hermodus, is no where elſe mentioned. But as there may have been many able architects, whoſe names, or works, have not been tranſmitted to us, I think it not neceſſary to differ from the text.

(17*) There were in Rome ſeveral temples of Honour and Virtue; one of that name was built by Marius, in conſequence of his victory over the Cimbri, which it is ſaid he built in a very plain manner, having no taſte for the arts. This, therefore, is probably the temple to which Vitruvius alludes.

Fig. XIX. Pseudo-dipteros has in the front and in the posticus eight columns, and in the flanks fifteen, including those of the angles. The walls of the cell correspond to the four middle columns of the front and of the posticus; so that the space of two intercolumns, and the thickness of one column, remains all round between the walls and the outer range of columns. No example of this is in Rome, but such is the temple of Diana at Magnesia, built by Hermogenes of Alabanda, and that of Apollo by Mnestæus.

Fig. XX. Dipteros is also octastyle[18*] in the pronaos,[19*] and in the posticus, but has a double range of columns around the cell. Thus is the Doric temple of Quirinus,[20*] and the Ionic temple of Diana at Ephesus, erected by Ctesiphonte.[21*]

Fig. XXI. Hypæthros is decastyle both in the pronaos and posticus; in all other respects it is the same as dipteros, except that in the inner part also it has columns (F); two rows in the height, detached from the walls all round, like the peristyle of a portico. Also the middle part (A) is left uncovered, and without a roof, and doors (C C) open both to the pronaos and to the posticus. Of this there is no example in Rome; but such is, at Athens, the octastyle temple, and that of Jupiter Olympius.[22*]

(18*) Octastylos signifies having eight columns; decastylos, ten columns; hexastylos, six; and tetrastylos four columns in the front.

(19*) The pronaos is the porch or porticus in front of the temple, as the posticus is that in the back front.

(20*) There were two temples of Quirinus at Rome; one on the hill of that name; the other on the Via Appia, without the city. It is said, that which was within the city was always kept shut, to denote the secret and unknown end of Romulus, who after his deification was called Quirinus.

(21*) This name is variously wrote, as, Cresophon, Chrysyphon, Chresipheon, Chtesiphrone, and Chersiphon. In the preface to the seventh book, and at the sixth chapter of the tenth book, Metagenes his son is also mentioned with him, as architect to the temple of Diana at Ephesus.

(22*) *Sed Athenis octastylos, & in templo Jovis Olympii*, are the words of the text, which I have rendered, *The octastyle temple at Athens, and that of Jupiter Olympius*; for it is not certain that we are to understand the word *octastylos* to relate to the temple of Jupiter Olympius, thereby determining that temple to be octastyle, as all the translators have generally understood. On the contrary, it appears to me, that Vitruvius means some other temple by the word *octastylos*; for he distinguishes it from *in templo Jovis Olympii*, by an (&), as I find by Galiani's edition of the text, and by all the manuscripts I have seen. There is also a similar passage just below. *Divi Julii & in Cæsaris foro Veneris*, in which the distinction between the two temples is made by the same sign, (&) and which the same translators have all allowed to express different temples; rendering it *the temple of the divine Julius, and that of Venus in Cæsar's forum*; although they might, with as much reason, have rendered this, *the temple of Venus in the forum of the divine Julius Cæsar*.

Thus much I had written when I saw the controversy between Mr. Stuart and Mr. Le Roi, concerning the temple of Jupiter Olympius. I need not mention the several reasons that might be alledged, why Vitruvius could not distinguish this temple any otherwise than by the number of columns in its front, or that it was sufficient so to do; but will only mention some circumstances, which make it probable that the temple of Jupiter Olympius was a decastyle temple.

Among the present ruins of Athens are seventeen Corinthian columns, (commonly called *the columns of Adrian*,) which Mr. Stuart, in his Antiquities of Athens, notwithstanding the answer of Le Roi, has given sufficient reasons to believe are the remains of the temple of Jupiter Olympius; they stand on the spot assigned by the ancient writers to that temple.

These seventeen columns are so disposed, that the longitudinal distance of the two most remote from each other is that of nineteen intercolumns, and their intermediate columns; so that this temple must have had twenty columns in flank.

This circumstance sufficiently evinces that the front must certainly have had ten columns; for if there had been no more than eight in front, there should have been but fifteen in flank, according to Vitruvius's principles; and but seventeen according to the custom of the Greeks, who usually placed in the flank one column more than double the number of those in the front.

If therefore these columns are truly the remains of the temple of Jupiter Olympius, we cannot doubt of its having been a decastyle temple: and consequently, that the word *octastylos* does not allude to that, but to some other Athenian temple.

CHAPTER II.

Of the Five Species of Temples.

THE ſpecies of temples are five, which are thus named; PYCNOSTYLOS, which has columns very cloſe; SYSTYLOS, a little more apart; DIASTYLOS, an ample diſtance; AREOSTYLOS, more diſtant than is proper; and EUSTYLOS, the juſt diſpoſition of the intercolumns. PYCNOSTYLOS is that in whoſe intercolumns the thickneſs of one column and a half may be contained. In this manner is the temple of the deified Julius, and that of Venus in Cæſar's forum. There are alſo ſeveral others thus compoſed. SYSTYLOS is that in whoſe intercolumns the thickneſs of two columns may be contained, and the plinths of the baſes are equal to the ſpace which is between two plinths.[1*] Thus is the temple of Equeſtrian Fortune, near the Stone Theatre; and ſeveral others are built in the ſame manner. Both theſe kinds are incommodious; for when the mothers of families, going to their ſupplications, have aſcended the ſteps, they cannot paſs arm in arm through the intercolumns, unleſs they paſs ſide-ways. The cloſeneſs of the columns alſo obſtructs the view of the door of the temple, and obſcures the ornaments; and the walks about the cell are inconvenient, by reaſon of their narrowneſs.

Fig. XIV. and XV. DIASTYLOS is that diſpoſition, in whoſe intercolumns the thickneſs of three columns may be placed. Thus is the temple of Apollo and Diana. This diſpoſition is attended with ſome inconvenience; for the Epiſtylium, on account of the width of the intercolumns, is liable to break.

Fig. XXXI. IN ARÆOSTYLOS, neither ſtone nor marble Epiſtyliums can be uſed, but beams of durable timber muſt be applied. The ſpecies of theſe temples are called *Barycæ Barycephalæ*,[2*] low and broad; and the ornaments of their faſtigiums are of fictile ware, or of braſs gilt in the Tuſcan manner. Thus, at the Circus Maximus, is the temple of Ceres, the Pompeianian temple of Hercules, and alſo that of the Capitol.[3*]

(1*) Conſequently the projecture of the baſe will be a quarter of the diameter of the column, which is much greater than is uſually allowed by the modern maſters, who, in general, allow the projection to be no more than the ſixth part of a diameter, or thereabout. See *Fig. XXV.* No. 1. and 2.

(2*) From the Greek words, βαρυς, low or flat, and κεφαλη, head.

(3*) Perault tranſlates this paſſage thus: *aux temple de Ceres et d'Hercule, qui ſont procche le grand cirque, et au Capitole, qui eſt en la ville de Pompei.* The text is, *Uti eſt ad Circum Maximum Cereris, et Herculis Pompeiani, item Capitolii.* My tranſlation agrees nearly with that of Galiani; for Pliny informs us, that there was a temple of Hercules built by Pompey, near the Circus Maximus; as alſo a temple of Ceres near the ſame: and Livy, in ſeveral places, mentions a temple of Hercules in the Capitol. The Tuſcan temple, Fig. XXXI. is an example of this ſpecies, excepting that the columns are there but ſeven diameters high, whereas in Areoſtylos they are directed to be eight.

Now, returning to the EUSTYLE manner, which is the moſt perfect, and beſt ſuited to the purpoſes of convenience, beauty, and ſtrength; the ſpace of the intercolumns is made equal to the thickneſs of two columns and a quarter; and one intercolumn in the middle of the front, and another in the poſticus, is equal to the thickneſs of three columns. Thus the aſpect will be handſome, the acceſs free from impediment, and the walk about the cell commodious. This ſpecies is thus regulated: The place deſigned for the front, if the temple is to be made tetraſtyle, is divided into eleven parts and a half, excluſive of the footings, and the projecture of the baſes. If it is to be of ſix columns, it is divided into eighteen parts; and if deſigned to be octaſtyle, into twenty-four and a half. By theſe diviſions, whether it is tetraſtyle, hexaſtyle, or octaſtyle, one part will be a module, and one module will make the thickneſs of the columns. Each intercolumn, excepting the middle one, has two modules and a quarter; the middle one of the front and of the poſticus has three modules; and the heights of the ſame columns are to be eight modules and a half: ſo that, by theſe diviſions, the intercolumns will be juſtly adapted to the heights of the columns. We have no example of this ſpecies in Rome; but ſuch is the octaſtyle temple of Bacchus at Teos, in Aſia.[4*] This ſymmetry[5*] was eſtabliſhed by Hermogenes, who alſo firſt invented the principle of the octaſtyle pſeudodipteros; for, in the dipteral temples he ſuppreſſed the interior range of columns, in number XXXVIII.[6*] and thus leſſened both the expence and the labour. This made the walk about the cell exceedingly ſpacious, and in nothing impaired the aſpect; ſo that, without the aid of the ſuperfluous columns, the dignity of the whole work was preſerved; for the pteromatos,[7*] and the diſpoſition of columns about the temple, was contrived ſolely to the end that the aſpect might be enriched by the aſperity[8*]

Fig. XX.

(4*) Some remains of this temple are now publiſhed in the Ionian Antiquities.

(5*) Symmetry is here uſed in the ſenſe in which ſpecies was before uſed. I have nevertheleſs choſe to give the word of the text, that the reader may obſerve the different application of the words.

(6*) The manuſcripts in general have XXXVIII. but it is believed to be an error of the copyiſts, and that it ſhould have been written XXXIIII. that being the number of columns in the interior range, as will be eaſily ſeen in referring to the draughts, Fig. XIX. and XX. I cannot imagine any more probable way of agreeing with the number of the text, than by ſuppoſing the two columns between the Antæ in the pronaos, and the two in the poſticus, (marked 1, 2, 3, 4,) were alſo ſuppreſſed, which, added to thoſe of the inner range, will then make up the number thirty-eight. This may not be thought improbable, when it is conſidered, that the ſuppreſſion of theſe four columns correſponds with the intention, and promotes the end deſigned, by ſuppreſſing the whole inner range of columns, *(i. e.)* opening and enlarging the walks about the temple.

Le Roi, in his Ruins of Greece, accounts for it in another manner, which has ſome probability. With the Greeks it was a general rule to make the number of columns in the flanks of their temples one more than double the number of thoſe in the fronts; ſo that where there were eight in front, there were ſeventeen in flank; from whence it happened, that the columns in the interior range of Grecian dipteral temples were in number exactly thirty-eight.

The only objection to this ſuppoſition is, that Vitruvius has before deſcribed but fifteen columns in the flanks of dipteral temples; and it may be ſuppoſed he alludes to thoſe temples, according to his own deſcription, and the manner of the Romans, rather than according to the Greek manner, of which he has before taken no notice.

(7*) Pteromatos, ſee note 14, chap. vii. book IV.

(8*) Aſperity is a term Vitruvius uſes to expreſs the frequency and intermiſſion of the columns and intercolumns. Its application may be owing to the analogy there is between column and ſpace, and the intermiſſion of ſubſtance and ſpace, which is the cauſe of the aſperity or roughneſs of bodies. The French now uſe the word *aſprette* as a common technical term.

of the intercolumns; alſo, if a number of people ſhould be detained there by violent rains, they may wait in the temple, and about the cell, without inconvenience. This is the diſpoſition of pſeudodipteral temples: by which it appears that Hermogenes made a great and ingenious improvement, and has left an example from whence poſterity may deduce the principles of the ſcience.

The columns of Areoſtyle temples are ſo formed, that their thickneſs may be the eighth part of their height. In Dyaſtylos the heighth of the columns is divided into eight parts and a half, and one part is given to the thickneſs. In Syſtylos, the height is divided into nine parts and a half, of which one is given to the thickneſs of the column. In Pycnoſtylos, the height is divided into ten parts, and one makes the thickneſs of the column. But the columns of Euſtyle temples, like thoſe of the Dyaſtyle kind, are divided into eight parts and a half, and one part conſtitutes the thickneſs of the ſhaft at bottom. Thus the columns will be proportioned to the intercolumns; for, as the diſtances between the columns increaſe, ſo the thickneſs of their ſhafts ſhould be increaſed in proportion; for if, in the Areoſtyle ſpecies, the thickneſs of the columns ſhould be no more than a ninth or tenth part of their height, they would appear too thin and ſlender[9*]; becauſe, on account of the width of the intercolumns, the air leſſens and diminiſhes, in appearance, the thickneſs of their ſhafts. On the contrary, if in pycnoſtylos, the columns ſhould have in thickneſs an eighth part of their heighth, they would, by reaſon of the cloſeneſs and narrowneſs of the intercolumns, have a ſwoln and

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(9*) Galiani, quoting Perault, remarks, that as there is the difference of a whole diameter between the height of dyaſtyle and ſyſtyle columns, and as the euſtyle ranks between thoſe two ſpecies, that the height of euſtyle columns ſhould alſo be in a mean proportion between both, and be nine diameters high, inſtead of being eight and a half.

This remark may be carried farther yet, and it may be hinted, that the euſtyle intercolumns may likewiſe be two and a half diameters, as the mean between thoſe of the dyaſtyle and ſyſtyle, inſtead of two and a quarter, which is nearer to the ſyſtyle: for it may be obſerved, that, notwithſtanding Vitruvius ſays, the thickneſs of the columns ſhould be proportional to their intercolumns, yet in the euſtyle ſpecies, the intercolumns (as preſcribed by him) incline moſt to the ſyſtyle, although the thickneſſes of the columns are wholly the ſame as the dyaſtyle. It might therefore be no bad regulation in the euſtyle ſpecies, to make the width of the intercolumns, as well as the proportional thickneſs of the columns, in the mean between thoſe of the dyaſtyle and ſyſtyle ſpecies; that is, the intercolumns two and a half diameters of the column, and the columns nine diameters high. From this paſſage, as well as from the ninth chapter of the fifth book, and elſewhere, we may collect, that, among the ancients, it was not the order, whether Doric, Ionic, or Corinthian, that determined the proportional magnitudes of the columns and their ſeveral members, but the ſpecies of intercolumniation made uſe of; and which latter was governed by the deſtination, ſituation, magnitude, and other circumſtances of the work. Vitruvius indeed fixes the heighth of Ionic columns to eight and a half diameters, the Doric to ſeven diameters, and the Corinthian to nine and one ſixth, where he treats of them ſeparately; yet, when he ſpeaks of their uſe in areoſtyle, dyaſtyle, and ſyſtyle work, he determines their proportion by the ſpecies of intercolumniation; and the proportion of their members, by their height, magnitude, place, &c. He alſo ſpeaks of the uſe of the Doric order in ſyſtyle and dyaſtyle work, in which the columns muſt be nine and a half, and eight and a half diameters high, notwithſtanding he gives but ſeven diameters to that order elſewhere.

Wherefore, in the examples antiquity has left us, we find Doric, Ionic, and Corinthian columns, and their members, of various proportions. In vain then do we ſeek to diſcover the principles which governed the ancients in proportioning their works, by comparing the ſeveral examples of the orders which they have left, when the order was not the circumſtance by which they determined their proportions; and in vain, therefore, do we endeavour to fix the proportions of parts, which never ought to be fixed or limited.

To enable us to make any probable inferences concerning the principles which determined the ancients in the choice of their proportions in any given example, we ſhould be acquainted with the deſtination, ſituation, and other circumſtances of the work, as at its firſt erection; without which, the dimenſions and proportions only will be uſeleſs, and our concluſions muſt be uncertain, if not erroneous.

deformed appearance; for ſymmetry ought to be obſerved in all kinds of work. The columns at the angles are alſo made a fiftieth part of a diameter thicker than the others; becauſe they, being more ſurrounded by the air, appear more ſlender: the deficiencies of the ſight muſt therefore be rectified by the judgment.

Fig. XXII. The diminution of the top of the column, at the hypotrachelium[10*] (h), is thus regulated: If the column (a b) is not leſs than fifteen feet high, the thickneſs at bottom is divided into ſix parts, and five of thoſe parts are given to the thickneſs at the top. If the height is from fifteen to twenty feet, the bottom of the ſhaft is divided into ſix parts and a half, and five and a half of thoſe parts make the thickneſs of the column at the top. If it is from twenty to thirty feet, the bottom is divided into ſeven parts, and ſix of theſe make the diminution at the top. If it is from thirty to forty feet high, the bottom thickneſs is divided into ſeven parts and a half, of which ſix and a half is the meaſure for the diminution at the top. If it is from forty to fifty feet, it is divided into eight parts, whereof ſeven make the thickneſs of the hypotrachelium at the top of the ſhaft. And, if it is ſtill higher, the ſame proportional method is to be obſerved; for, as a greater heighth cauſes them to appear more diminiſhed, they are therefore to be corrected by an addition of thickneſs; beauty being the province of the eye, which, if not ſatisfied by the due proportion and augmentation of the members, correcting apparent deficiencies with proper additions, the aſpect will appear coarſe and diſpleaſing. Concerning the augmentation that is made in the middle of columns, which by the Greeks is called *Entaſis*, the manner of forming it juſt and gradual is ſhewn by the draught at the end of the book.[11*]

(10*) The Hypotrachelium is the neck or upper part of the ſhaft of the column.

(11*) This draught, with all the others which Vitruvius annexed to his book, are loſt; we are therefore left unacquainted with the method the ancients uſed, in forming the ſwell or Entaſis of columns. All the commentators have taken it for granted, that Vitruvius intended the ſwell to be beyond the perpendicular of the bottom of the ſhaft, thereby making the column thicker in the middle than at the bottom; and it ſeems not to have occurred to them, that he might poſſibly mean, that the ſwell ſhould riſe from the inclined line that paſſes from the bottom of the ſhaft to the point of diminution at the top; although this latter is as conſonant to the text as the former, and is much more beautiful and conformable to the antique: they have therefore charged Vitruvius with inculcating a rule, which neither propriety, beauty, or the example of antiquity, recommends; and which gives the column ſo deformed and diſpleaſing an appearance, that few architects, if any, have thought proper to practiſe it.

Vitruvius has juſt told us, that columns are leſs at the top than at the bottom; conſequently a column, in his ſenſe, is a conical, not a cylindrical body. When, therefore, he ſays columns have ſuch a quantity of ſwell in the middle, he muſt mean that that conical body has ſuch a ſwell, or that the ſwell is from the conical or inclined line; and cannot mean from a cylindrical or perpendicular line, which he no where deſcribes. If he had deſcribed columns to be cylinders, then the cylindric or perpendicular line muſt have been underſtood; but, as he deſcribes them to be conical bodies, his words admit no other than the conical or inclined line to be accepted.

In many ancient columns yet remaining, we find the line which paſſes from the bottom to the point of diminution at the top, to be quite ſtrait; but in the greater part of thoſe in the Roman buildings, that line is obſerved to have a gentle ſwell or curvature; ſuch, in fact, as columns would have, were they formed according to the ſuppoſition that the ſwell deſcribed is to be underſtood to riſe from the aforeſaid inclined line (a b, fig. XXII.) and not from the perpendicular line (a o). Reaſon, beauty, and the example of antiquity, therefore, all conſpiring to ſupport this opinion, as much as to diſprove the other, it becomes more than probable that this was the meaning of Vitruvius.

From a paſſage at the end of this book we learn, that the quantity of the ſwell or entaſis in the middle of columns is equal to the ſize of one of the fillets between the channels.

CHAPTER III.

Of the Foundations, and of the Columns and their Ornaments.

FOR the foundation of theſe works, the ground muſt be dug down to the ſolid earth, and in the ſolid ſo far as ſeems needful for the magnitude of the building. The ſubſtructure muſt be made extremely ſtrong. The walls above ground, under the columns, are made thicker by half than the columns which reſt upon them, that the inferior may be ſtronger than the ſuperior, and that the baſes may not project beyond their ſupport.[1*] Theſe walls are called *Stereobatæ*, becauſe they ſuſtain the whole weight. The thickneſs of the walls above muſt alſo be wrought in the ſame manner, and the interval either vaulted or made ſolid by piling, whichever may be beſt approved. But if the place is found to be infirm, ſoft, and marſhy to the bottom, then it muſt be dug and emptied, and piles of alder, olive, or oak ſcorched, driven in by machines very cloſe together, and the intervals of the piles rammed with coal; after which the ſubſtructure is to be completed in the moſt compact manner.

Fig. XVIII. The foundation being raiſed, the ſtylobatæ (g) are all placed on a level, erecting the columns upon the ſtylobatæ, either in the pycnoſtyle, ſyſtyle, dyaſtyle, or euſtyle manner, as before deſcribed and determined. In the areoſtyle manner they may be diſpoſed at pleaſure. In peripteros the columns are ſo ordered, that as many intercolumns as there are in front, twice ſo many of the ſame intercolumns are made in the flanks; and thus the length of the work will be double its breadth. Thoſe who make the number of columns double, miſtake; becauſe, in that caſe, the length will be one intercolumn too much.[2*]

The channels, as well as fillets, are uſually twenty-four in number, and the latter are to the former as one to three; one fillet muſt therefore be equal to the ninety-ſixth part of the circumference of the column, or about the thirtieth part of the diameter, which therefore muſt be the quantity of the ſwell in the middle of the ſhaft.

The method of deſcribing it may be as follows. A ſtrait line (a b fig. XXII.) being drawn from the bottom of the ſhaft to the point of diminution at top, that line is divided, and at the middle the quantity (c p) of the ſwell is marked off outwardly; a regular curve, or portion of a circle, is then drawn, paſſing through thoſe three points, the bottom (a), the top (b), and the entaſis in the middle (p).

(1*) Vitruvius has before mentioned, that the baſes project a quarter of a diameter of the column beyond the ſhaft; ſo that the projection of the baſe on both ſides, added to the diameter of the column, is equal to one diameter and a half of the ſaid column.

(2*) All the commentators have obſerved, that if the number of intercolumns in front are doubled, the length of the temple will not even then be exactly twice its breadth, but will be one diameter of a column ſhort of twice its breadth. This is true, if we meaſure to the outſides of the columns both ways; but if we reckon from the centers of the columns either way, which ſeems to be Vitruvius's intention, his rule is perfectly juſt, and agrees, in this reſpect, with the ancient temple of Concord at Rome, and that of Niſmes in France. The Greeks differed from the Romans in this matter, and generally placed in the flanks of their temples one column more than double the number of thoſe in the front.

Fig. XVIII. The ſteps (h) in front are ſo contrived, that they may be always of an odd number, that the right foot aſcending the firſt ſtep, may alſo be firſt placed on the pavement of the temple. The ſize of the ſteps, I judge, ſhould be ſuch, that they may not be thicker than the dextant, nor thinner than the dodrant[3*]; for, in that caſe, the aſcent will not be tireſome. The breadth of the ſteps is made not leſs than a foot and a half, nor more than two feet. If ſteps are diſpoſed all round the temple, the ſame rules ſhould be followed; but if a podium[4*] is made round three ſides of the temple, it is ſo formed, that its plinth (l), baſe (o), dye (r), corona (s), and lyſis,[5*] may agree with the ſame ſtylobata which is under the baſes of the columns.[6*]

Fig. XXII.

The ſtylobatæ ſhould be wrought in ſuch a manner, as to leave in the middle the adjection for the unequal ſcamilli; for, if directed level, it will ſeem to the eye to be channelled. But

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(3*) The dextant is the five ſixths of any meaſure, as the dodrant is the three fourths. Galiani argues on it as a doubtful matter, whether we are here to underſtand them to be parts of a foot or of a palm. I cannot have a doubt but that they ſhould be underſtood to be parts of the foot; becauſe Vitruvius, immediately after, gives the breadth of the ſteps in feet; and it is not very probable that he would give the thickneſs in one meaſure, and the breadth immediately after in another: beſides, the Roman palm, being only a quarter of a foot, was too ſmall a meaſure to admit a ſuppoſition that the ancient ſteps were ſo diminutive as to be a portion thereof. The Roman foot was eleven ſix tenths of our foot; conſequently the dextant of their foot was a little ſhort of ten inches of our meaſure, and the dodrant a little ſhort of nine inches. The ancient ſteps, therefore, were much higher and broader than thoſe now uſed by the moderns. In one of the ancient temples ſtill remaining at Athens, the ſteps are of the meaſure here aſſigned; and in the remains of ſome temples at Peſtum in Italy, they are much larger.

Perault has accepted the word *retractiones* for the landings between the ſteps, which here only ſignifies the breadth or tread of the ſteps, as Galiani ſufficiently evinces and corrects.

(4*) The Podium is the continuation of the pedeſtal through the intercolumns, or, as we call it, the *Dado*.

(5*) It is not agreed on, what member Vitruvius means by the word *lyſis*; he uſes it again at chap. vii. book V. and at chap. xi. book VI. at which laſt place he applies it to fractures in buildings. To judge from the order in which the parts of the ſtylobatæ are named, it ſhould be ſome member above the corona; and may therefore be the ogee or cymatium, or, as ſome think, the weathering or ſlope above the cymatium, which lays on the corona.

(6*) Galiani explains this paſſage, by ſuppoſing, that the ſtylobatæ were raiſed above the pavement of the temple; but that was very rarely practiſed by the ancients, as is evident from the examples which have come to our knowledge. The tops of the ſtylobatæ were uſually no higher than the pavement of the temple, and the height of the ſteps determined the height of the ſtylobatæ.

Vitruvius ſpeaks of temples that had ſteps all round, and of another kind that had ſteps only in front, with a continued podium round the other three ſides. As in this latter caſe there appears no occaſion for ſtylobatæ, becauſe the podium is the ſupport of the columns, and as Vitruvius has mentioned ſtylobatæ under the columns, beſides mentioning the podium, Galiani has been induced to believe, that Vitruvius alluded to an inſtance where the ſtylobatæ were raiſed upon the pavement of the temple, and above the top of the ſteps: but the fact is, as we may gather from the context, that ſtylobatæ were always firſt built under the columns, whether the temple was to be encompaſſed with a podium, or with ſteps; in the latter caſe, they were only plain ſquare piers, hidden by the ſteps; in the former, they had their *quadræ*, *ſpiræ*, and *corona*, on the outer part. The podium walls were afterwards built between them, fluſh outwardly, but not inwardly; it not being neceſſary to make the podium ſo thick as the ſtylobatæ which ſupported the columns; and theſe podium walls had, as Vitruvius ſays, their plinth, baſe, corona, &c. correſponding with thoſe on the external part of the ſtylobatæ. This is confirmed by an ancient temple at Cora in Italy, where the ſtylobatæ under the columns ſtill remain, although the podium that was built between them is fallen; and which ſtylobatæ appear to have been built of ſtones ſuited to their own dimenſions, and unconnected with the adjoining podium.

the manner of properly forming theſe ſcamilli will be ſhewn by the figure and deſcription at the end of the book.[7*]

(7*) This paſſage concerning the ſcamilli is univerſally allowed to be one of the moſt obſcure and unintelligible parts of the whole work, and has much employed the thoughts of the tranſlators and commentators of this author to explain. Baldus has written a treatiſe, intitled *Scamillos impares*, purpoſely to explain it. He ſuppoſes the ſcamilli to be ſubplinths, ſituated under the ordinary plinths of the baſes of the columns, forming a double plinth under the ſame, as is ſeen in the temple of Fortuna Virilis at Rome. Baptiſta Bertanus ſuppoſes them to be projections in the dye of the ſtylobatæ, like the ſeveral faces of the architrave, and to which they alſo anſwer in the perpendicular. Some have thought the ſtylobatæ to have a protuberance in the middle of the face or dye, like the ſwelling of a circular friſe; and others ſuppoſe the ſcamilli to be nothing more than the projections of the podium under each column, forming a ſtylobata to every column, inſtead of one continued and uninterrupted podium; and they account for the appearance of channelling, which Vitruvius ſpeaks of, by ſuppoſing the receſſes, which are formed by the alternate projection and receſs of the podium, to be the channelling meant; or elſe that the dye itſelf is the channel, as being ſunk between the projection of the capping and baſe mouldings. But it was not the practice of the ancients to make ſuch breaks in the podium of temples, as has before been noticed; and the other ſuppoſitions are ſo foreign to the ancient manner, that they are far from being ſatisfactory, or even plauſible.

The order Vitruvius obſerves in mentioning the ſeveral parts of the fabric, beginning from the foundation, and riſing part by part, as they are ſituated next in height, is a powerful, and, I could almoſt ſay, inconteſtible, argument, to prove, that the ſcamilli are ſituated between the tops of the ſtylobatæ and bottoms of the baſes of the columns; and the meaning of the word ſcamillus, which is that of a little bearer, footſtool, or riſer, intimates that they are ſome kind of bearer, upon which the columns may ſtand, ſo far agreeing with the ſuppoſition of Baldus. Vitruvius gives us to underſtand, that they are an addition in the middle of the ſtylobatæ, or, more ſtrictly, that the addition is left for them, and that regard muſt be had thereto in working or levelling the ſtylobatæ, ſo as to leave that addition; but he does not ſay whether this addition is to be in the middle of the top, or of the front, or of the ſide, &c. However, the argument before mentioned ſufficiently evinces, that it is the middle of the top or horizontal ſurface which is meant.

Another circumſtance Vitruvius mentions concerning them is, that if this top of the ſtylobatæ is made level or ſtrait, it will ſeem to be channelled or grooved. Here the ſuppoſition of Baldus fails: it cannot appear channelled, however the top of the ſtylobatæ may be wrought; nor does it agree in the inequality or diſſimilarity which Vitruvius aſcribes to the ſcamilli, calling them *ſcamillos impares*. Theſe circumſtances, and a paſſage farther on, which mentions ſome relation the ſcamilli have to the epiſtylium or architrave, are the great obſtacles and difficulties of the ſolution.

There might be ſeveral devices, very different to each other, offered, that would agree with the circumſtances of the deſcription more or leſs aptly; but the deſcription itſelf is not ſufficiently explicit to enable us to determine on any one with certainty; and no antique example has yet been noticed that can aſſiſt us in the inveſtigation. As one of the moſt probable, out of many, which have occurred to me, and as it differs from all others that have been offered for explaining this difficulty, I mention the following, leaving it to the world to decide on its probability or value.

I have before aſſented to the opinion of Baldus ſo far as to allow the ſcamillus to be a riſing or adjection on the level top of the ſtylobatæ; but I do not agree with him in ſuppoſing it to be a ſubplinth. My notion is, that it is a ſmall riſing, ſcarcely ſo high as one of the fillets of the baſe is thick, and its meaſure horizontally ſomething leſs than the ſquare of the plinth of the baſe which reſts on it, as (m, n, fig. XXII.)

With regard to the uſe of this riſing, or ſcamillus, I ſuppoſe it to be the ſame as that ſimilar ſmall riſing or adjection (i, k), uſually found between the capital and architrave, in many of the ancient buildings; viz. to prevent rupturing the edges of the baſe, to correct the minute inequalities in the heights of the columns, ſo as to preſerve the level of the epiſtylium, and to give the columns on the flanks that inclination inward which Vitruvius directs; for it is to be expected as unavoidable, that, in working ſo great a number of columns as were placed around peripteral temples, ſome ſmall inequalities of height would happen, eſpecially in caſes where the columns were wrought at the quarry, at a great diſtance from the building, as was often the caſe.

To ſuch purpoſes ſuch adjections or ſcamilli were perfectly adapted, and may even be ſaid to be neceſſary, and they will anſwer to every circumſtance of the deſcription.

For, 1ſt, With regard to their inequality or diſſimilarity, theſe adjections on the ſtylobatæ being left ſufficiently high, and afterwards worked down more or leſs, ſo as to ſuit the height, or the inclined poſition of the columns reſting upon them, they of courſe become unequal in their thickneſſes or heights, on account of the unequal heights of the columns, as well as on account of their inclined poſition, which conſequently occaſions the adjection to be higher under ſome columns than under others, and on one ſide than on the other. 2d, They appear as if channelled or grooved, becauſe their meaſure is a little leſs than the ſquare of the plinth of the baſe, in order to avoid rupturing the edges of the ſaid plinth; wherefore there appears to be a groove or channel between the ſtylobatæ and the baſe of the column, which will ſeem to be wrought on purpoſe, provided the

Fig. XXVI. No. 1. THIS done, the baſes are fixed in their places, and are ſo proportioned, that, including their plinth, they have in height half the thickneſs of the column; and in projection, which the Greeks call *Ecphoran*, a quarter; ſo that their breadth and length will be once and an half the thickneſs of the column. Their height, if they are to be in the Attic mode, is ſo divided, that the upper part is one third of the thickneſs of the column, and the remainder is left for the plinth (r). The plinth being excluded, the remaining part is divided into four parts, and the upper torus (t) has one fourth; the remaining three parts are equally halved, and one half makes the lower torus (t t), and the other the ſcotia (s), which the Greeks call *Trochilon*, with its ſquares.

Fig. XXIV. No. 1. BUT if the baſes are to be made in the Ionic mode, they are ſo proportioned, that their meaſure on every ſide be equal to the thickneſs of the column, added to a quarter and an eighth of the ſaid thickneſs. The height is the ſame as in thoſe of the Attic kind; ſo alſo is the plinth. Excluding the plinth, the remainder, which will be equal to the third part of the thickneſs of the column, is divided into ſeven parts, of which three are for the torus (t) that is at the top; the remaining four parts are equally halved, and one part makes the upper trochilus (s), with its aſtragals and ſupercilium[8*], and the other part is left for the lower trochilus (s s); but the lower one appears to be the largeſt, becauſe it projects to the extremity of the plinth[9*]. The aſtragals are the eighth part of the trochilus. The projecture of the baſes is an eighth, and a ſixteenth part of the thickneſs of the columns.

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line is made ſtrait or level; for otherwiſe it would appear as a defect or accident. In this manner the adjections are found between the capital and architrave in the temple on the Iliſſus at Athens are formed, as (i-k, fig. XXII.); though in the Roman buildings, as in the portico of Octavia, the temple of Antonine and Fauſtina, the Thermæ of Dioclesian, &c. they are made larger than the incumbent epiſtylium. Laſtly, concerning the correſpondence theſe adjections have to the epiſtylium: As it has been made appear with the greateſt probability, that the adjections muſt be a kind of flat horizontal bearers, which are covered by the immediately incumbent baſes, it is evident, that the correſpondence alluded to cannot conſiſt in any apparent ſimilarity of form between them and the members of the epiſtylium, as it has been generally ſuppoſed; the adjections can only be more or leſs high, and, of courſe, the incumbent parts more or leſs raiſed, ſo as to correſpond to ſuit the level of the epiſtylium; and this, I imagine, is all the correſpondence alluded to between the adjections in the ſtylobatæ and the members of the epiſtylium, that is meant by Vitruvius. But this will be farther diſcuſſed at Note 17.

I know not to what it may be imputable, that none of theſe adjections have been found, or at leaſt noticed, under the baſes of the columns in any of the antique edifices; they are found very frequently over the capitals. Indeed, the moldings of the baſes are generally more mutilated and confuſed, which may prevent the obſervation of ſo ſmall a member, and may make it appear of one piece with the decayed face of the plinth. They alſo may not have been uſed under the baſes in all buildings, as they were not in all buildings uſed over the capitals. In the Sybil's temple at Tivoli, there are ſuch adjections to be ſeen under the torus of the baſes, (for they have no plinth), which is the only inſtance I know of in which there is any appearance of them; and, in this temple, the columns have that inclination inward which Vitruvius directs. See note 17, enſuing.

(8*) Supercilium ſignifies in general any ſuperior molding that crowns or terminates another member. In this caſe, it muſt mean ſome molding reſting upon the ſcotia; but what particular molding cannot be aſcertained.

(9*) Vitruvius ſays, the lower trochilus appears larger on account of its larger projection, or (in his own words) becauſe it projects to the extremity of the plinth. This implies, that it is in fact no higher than the upper trochilus; and, if ſo, it muſt have its aſtragals and ſupercilium, as well as the upper trochilus. Alſo, as aſtragals are mentioned in the plural, it follows, that there muſt be two aſtragals to each trochilus. Again, as the trochilus muſt be terminated by ſome member both at top and bottom, and as the proportions of the aſtragals are mentioned, and no notice taken of the ſupercilium, it is probable that one aſtragal was at top, and the other at the bottom; and that the aſtragal at top is the molding here called the SUPERCILIUM; for, if the ſupercilium was any diſtinct molding, it is to be ſuppoſed that Vitruvius would have mentioned its proportion, as well as that of all the other moldings in the baſe.

THE baſes being compleated and fixed, the middle columns both of the pronaos and poſticus are to be ſet perpendicularly on their axis; but thoſe which are ſituated at the angles, and thoſe on the flanks of the temple, to the right and left, have their inner faces, which are toward the walls of the cell, diſpoſed perpendicularly, and their outer faces diminiſhed as directed; for, by this means, the temple will have a juſt and proper diminution.[10*]

Fig. XXIV. and XXV. THE ſhafts of the columns being erected, the capitals, if they are to be of the pulvinated[11*] kind, are to be made as follows: The Abacus is in length and breadth (a b) equal to the thickneſs of the bottom of the ſhaft, added to an eighteenth part thereof; and the heighth (d c), including the volutes, is the half. At the extremity (a) of the Abacus, an eighteenth part and a half (a d) is to be ſet back toward the inner part of the faces of the volutes; and from thoſe four points, near the extremes of the Abacus, four lines (d c), which are called *Catheti*, are drawn downward. Then the thickneſs (d c) is divided into nine parts and a half, and of theſe nine parts and a half, one part and a half is left for the thickneſs (d f) of the Abacus, and the remaining eight are reſerved for the Contour of the volute. After this, the lines (d c), which are drawn down, at the extremes of the abacus, and recede inwardly one part and a half, are ſo divided, that four parts and a half are left under the abacus; and at that point which ſeparates four parts and a half from three parts and a half, the center of the eye (i) is marked, and round this center a circle is drawn, equal in diameter to one of the eight parts. This will be the ſize of the eye, and in this cathetus the correſponding diameters[12*] are wrought. Then beginning at top, under the abacus, in the ſeveral operations of the quarters, the halved ſpace of the eye is diminiſhed, till it returns to the ſame quarter under the abacus.

Fig. XXIV. and XXV. THE thickneſs of the capital is ſo divided, that, of nine parts and a half, three fall below the aſtragal (F) at the top of the ſhaft. The parts above are left for the cymatium,[13*] abacus (f), and channel (H). The projecture (n) of the cymatium, beyond

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(10*) The text does not explain whether in theſe columns on the flanks the diminution on the outſide is equal to the whole quantity of the diminution made on both ſides of the other columns, or only the quantity made on one ſide; but moſt probably the whole quantity is meant: for otherwiſe theſe columns would be larger at the top than the others, which would cauſe a diſproportion and diſſimilarity in the capitals, and in the ſoffite of the epiſtylium. The columns of the Sybil's temple at Tivoli, are thus inclined, and have the whole diminution on the outer face.

The columns which are to be inclined are, I imagine, to be properly diminiſhed, before they are erected; and the proper inclination is then given them, by diſpoſing their axes out of the perpendicular ſo far, till the top of the ſhaft on the inner ſide becomes perpendicular with the bottompart.

(11*) Pulvinated, or bolſtered, is a term applied to the Ionic capital, on account of its volutes reſembling the ends of matraſſes rolled up in the form of bolſters or cuſhions.

(12*) By *reſpondens diametros*, correſponding diameters, I ſuppoſe, we are to underſtand, correſponding centers; (*i. e.*) the centers which turn the ſeveral contours of the volute.

Theſe central points are ſaid to be in the cathetus of the eye: wherefore it ſhould ſeem that the method of turning the volute here intimated, is like that given by Serlio, where all the central points are formed in the cathetal line, within the diameter of the eye. This method, however, gives an unhandſome oblique direction to the volute, and is not to be recommended.

(13*) The molding, here called the *cymatium*, is judged to be the echinus, or ovolo, (G, fig. XXIV. and XXV.

the ſquare of the abacus, is equal to the ſize of the eye. The balthei[14*] (e) of the bolſters have ſo much projecture from the abacus, that, when one foot of the compaſſes is placed in the quarter of the capital (m), and the other extended to the extremity of the cymatium (n), the circumferent line (n e) may touch the extreme parts of the balthei. The axes of the volutes (g) are no thicker than the ſize of the eye, and the volutes are ſo inchaſed, that the depth is the twelfth part of their breadth. Theſe are the proportions of capitals for columns not more than fifteen feet high[15*]; thoſe which are higher have their ſymmetry accordingly.

The abacus will be in length and breadth equal to the thickneſs of the bottom of the column, and one ninth part[16*]; ſo that, as the higher the column is, the leſs is its diminution,

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(14*) The balthei, which ſignify bands or girdles, may probably be the moldings (e), which begirt the bolſter or profile of the volutes.

(15*) The receſs (a d) of the cathetal line from the extremity of the abacus, as deſcribed by Vitruvius, has been generally thought too much, being one part and a half of the eighteen parts, into which the bottom of the column is divided, cauſing the cymatium or ovolo to have a very large projection. Some therefore have ſuppoſed the text to have been corrupted: and Palladio Alberti, Vignola, and ſome others, have allowed it but one eighteenth part, intirely ſuppreſſing the half part. Scamozzi and Barbaro have given it one part and a quarter. The projection may be large, but it nevertheleſs ſeems to be ſuch as was intended by Vitruvius; for it makes the projecture of the abacus no more than equal to its heighth, which is conformable to his general rule in all moldings.

As the draught of this capital, as well as the other figures, which Vitruvius annexed at the end of his book, are loſt, it is not poſſible from this brief deſcription to underſtand perfectly his method of forming the volute. What has been ſaid above, at note 12, encourages an opinion, that it is ſomething like Serlio's. On the other hand, his ſpeaking of the operations of the ſeveral *quarters*, makes it ſuppoſable that it is one of thoſe methods in which each point turns a quarter circle only; whereas, if all the points are in the cathetal line, as in Serlio's method they are, each point muſt turn a ſemicircle.

There are many different methods in uſe for turning the Ionic volute, which are deſcribed in the many books of architecture now extant, and to which therefore I refer the reader. Nicholas Goldmanno has publiſhed a tract concerning the Ionic volute of Vitruvius, where he ſuppoſes he has diſcovered Vitruvius's method. It is nearly like that method given by Mr. Riou in his Grecian orders, and ſaid to be the ſame by which the volutes of the Ionic temple on the Iliſſus at Athens were formed.

The method given by Galiani in his tranſlation of Vitruvius, appears ſimple, eaſy, ingenious, and very conformable to the words of the text; but the centers are ſo diſpoſed, that the contours of the ſeveral quarters do not coincide in a right line, but form angles where they meet each other.

I ſhall here deſcribe a method of turning the Ionic volute, that has occurred to me, as it is eaſy to practiſe, and gives the volute a fine contour, very nearly agreeing with that of the theatre of Marcellus, according to Deſgodetz, which has never yet been decyphered. The eye being drawn, according to Vitruvius's inſtructions, the cathetal line (o p, fig. XXV.) is put on the diagonal, (*i. e.*) on an angle of 45), the upper part leaning outward, and continued indefinitely; then, on this line, the eye is divided into four equal parts, 1, 2, 3, 4, which are the centers for turning the volute. The point 1, where the diagonal cathetus interſects the lower part of the circumference of the eye, turns from its perpendicular f, at the bottom of the abacus, till it meets the diagonal cathetus at o. The point 2, diametrically oppoſite, is the center that turns the ſemicircle o p; the point 1 again turns the next ſemicircle p q; 3 turns the next q r; 4 the next r s; 3 again turns the next s t; laſtly, taking the middle 5 between t and 2, 5 becomes the laſt center, turning the ſemicircle t 2.

If the diagonal cathetus is turned on the other ſide, the perpendicular, that is, the under part, being directed outward, as from (u) to (u), the ſame proceſs will deſcribe an oval volute, having its longeſt diameter the contrary way.

(16*) The meaſure of the abacus was before ſaid to be a diameter and an eighteenth, here it is ſaid to be a diameter and a ninth; this the commentators account for, by ſuppoſing the former to relate to columns under fifteen feet, and the latter to all above that heighth; thereby ſuppoſing that the projection of the capital ſhould be greater, in proportion as it is ſituated higher; which ſeems to me to be contrary to the intention of Vitruvius.

For Vitruvius ſpeaks a little below of encreaſing the proportional heighths of members that are ſituated in high places; and for the ſame reaſon as the heighths are encreaſed, the projectures in ſuch ſituations ſhould be diminiſhed. He

for the ſame reaſon the capital is not without its due limitation of projecture, and its proportional addition of heighth. Concerning the deſcription of the volute, the draught and method of properly turning it with the compaſſes is ſhewn at the end of the book.

THE capitals being finiſhed, they are then fixed on the top of the ſhafts of the columns, not according to the level, but according to the equal modulary proportion; that an adjection like that made in the ſtylobatæ, may, in the upper parts, correſpond to the ſymmetry of the epiſtyliums.[17*]

alſo fixes the projecture of the epiſtylium to be ſo much in all caſes as ſhall make it perpendicular to the diameter of the column at bottom; by which it ever becomes proportionally leſs in projecture, as its ſituation is higher. See note 18.

This therefore directly oppoſes the opinion that the abacus ſhould be proportionally larger, as the column is higher, and is a reaſon for believing it ſhould be quite the contrary.

The commentators have been led into this opinion by the ſentence following: *Uti quo minus habuerit altior columna contractum*, EO NE MINUS HABEAT CAPITULUM QUÆ SYMMETRIÆ PROJECTURAM, *& in altitudine ratæ partis adjectionem*; they accepting *ne minus* for *more*; whereas it is, in my opinion, uſed only in the ſame ſenſe as *nec minus*, or *non minus*, is frequently uſed in divers other places, *viz.* for *not leſs than the reſt*, *neither*, *as well as*, &c.

As therefore it is doubtful which of theſe two dimenſions is the right, and Vitruvius's rule for the proportion of the abacus of courſe remains uncertain, we muſt apply to the works of the ancients for information, and by their help form our opinion.

In the temple of Fortuna Virilis at Rome, the abacus of the column is a diameter and an eighteenth, its heighth from the ground is thirty-ſix feet French, and the proper heighth of the column is twenty-five feet.

In the theatre of Marcellus, the abacus is a diameter and a thirtieth, its heighth from the ground is fifty-four feet, and the column is twenty two feet high.

In theſe two examples therefore we find the abacus is proportionally leſs, as its real height is greater, agreeing with the implication of the context, and directly oppoſing the conſtruction of the tranſlators.

By this it appears, that the firſt mentioned proportion of the abacus, *viz.* a diameter and an eighteenth, is moſt probably the true one, and the latter the miſtake; and alſo, that *ne minus habeat capitulum ſuæ ſymmetriæ projecturam*, muſt be underſtood to ſignify, that the proportional meaſure of the abacus muſt be diminiſhed, not encreaſed, in proportion as the columns are higher. And, laſtly, if the latter meaſure, *viz.* a diameter and a ninth, ſhould not be a miſtake, it more likely is meant for the meaſure of the abacus of columns fifteen feet high and under, and the former meaſure for thoſe which are above that heighth.

(17*) This is the paſſage before referred to, wherein the adjection in the ſtylobatæ is again mentioned.

In this place it is ſignified, that in fixing the capitals on the columns, the level is not regarded, but the equalem modulum only; (that is, the equal and proportional heighths of the columns, according to the number of modules aſſigned) to the end that the adjection mentioned may correſpond to the epiſtylium. Hence the correſpondence the adjection has with the epiſtylium muſt be of ſuch a kind as ſuffices or anſwers for the want of levelneſs in the capitals; and the adjection muſt be ſomething adapted to ſuch a correſpondence; for the epiſtylium muſt indiſpenſably be ſupported level.

If then the tops of the capitals of the columns that ſupport the epiſtylium, are, when fixed, not all on a level, ſome means muſt be found to make them ſo, or to anſwer the deficiency.

Vitruvius ſays the adjection is to anſwer this end; it muſt therefore be a kind of raiſer or bearer of an unequal thickneſs, according as the tops of the capitals vary from the level, ſo as to cauſe the tops of the capitals to correſpond with the level of the epiſtylium; which is, I imagine, all the correſpondence of the adjection to the epiſtylium that is meant.

Thus far it favours the former opinion concerning the nature of this adjection or ſcamillus.

But this paſſage has, in my conception, a different ſignification to that given it by the commentators in general. They have interpreted it, ſo as to import, that the adjection in the ſtylobatæ has ſome correſpondence with the epiſtylium, and the ſuperior members. I underſtand, that the adjection in the ſtylobatæ is here ſpoken of only by way of compariſon, and that it is another ſimilar adjection (here directed to be made), which is ſaid to correſpond with the epiſtylium, or ſuperior parts.

The reading is, *Uti quæ adjectio in ſtylobatis, facta fuerit in ſuperioribus membris, reſpondeat ſymmetria epiſtyliorum*, which is ambiguous, and will admit of both conſtructions; the reaſons therefore which have governed my choice are thoſe ariſing from the concurring circumſtances of the context.

Vitruvius directs the columns on the flanks of the temple to have their axes inclined out of the perpendicular. The axes of the capitals and baſes muſt undoubtedly coincide with thoſe of the columns. The top ſurface, or bed of the

The proportion of the epiſtylium (A D) is as follows: If the columns are from twelve to fifteen feet, the heighth of the epiſtylium is half the thickneſs of the bottom of the column. If from fifteen to twenty feet, the heighth of the column is divided into thirteen parts, and one part makes the heighth of the epiſtylium. If from twenty to twenty-five, the heighth is divided into twelve parts and a half, of which one part makes the heighth of the epiſtylium. If from twenty-five to thirty feet, it is divided into twelve parts, and one part makes the heighth. In this manner, according to the heighth of the columns, the heighth of the

capital, and that of the baſe, being at right angles with their axes, will therefore be out of the level. This circumſtance makes it indiſpenſably neceſſary to have ſome projection, bearer, &c. on the tops of the capitals, as well as under the baſes of thoſe columns, to rectify that obliquity, and preſent a level bed to the ſoffite of the epiſtylium. Likewiſe the unavoidable minute inequalities in the heighths or levels of the perpendicular columns, as well as for other reaſons before mentioned, make the ſame contrivance very proper, uſeful, and requiſite in thoſe columns alſo. Accordingly, we find the ancients generally uſed ſuch adjections or bearers on the tops of the capitals, as the remains of their works ſufficiently evince, in the manner (i k), fig. XXII.

Adjections on the capitals being then ſo neceſſary, convenient, and generally uſed by the ancients, it is ſcarcely to be ſuppoſed that Vitruvius would omit to ſpeak of them, eſpecially, as he has before ſpoken of a ſimilar minutia in the ſtylobatæ.

It has been before noticed, that Vitruvius treats of each part of the fabric according to the order of its height, beginning from the foundation, and ſo proceeding upward. He ſpoke of the adjection in the ſtylobatæ, between the ſtylobatæ and the baſe: here he ſpeaks of an adjection again, between the capital and the epiſtylium, which is the proper place of the adjection on the capital, and in which place they are found in the ancient remains.

Hence it is highly probable, that this latter adjection, which he here mentions, is that between the capital and epiſtylium, and not the ſame adjection that was before mentioned in the ſtylobatæ. But the next argument may be more convincing, if not deciſive.

It is ſaid, in fixing the capitals, the level is not regarded, to the end that the adjection (which ever it is) may, in the upper parts correſpond to the epiſtylium.

The nature of the correſpondence between the adjection and the epiſtylium has been before demonſtrated. The adjection in the ſtylobatæ cannot have ſuch correſpondence; for, however it may be formed, it cannot raiſe the declined bed of the capitals of the inclined columns to a level, without reverſing the inclined poſition of the columns, and cauſing them to lean outward inſtead of inward. This will be readily perceived upon a little reflection.

It cannot be ſuppoſed that the nature of the correſpondence between the adjection and the epiſtylium conſiſts in a ſimilarity in figure or meaſure, as has been heretofore ſuppoſed by former tranſlators; for the words, *The capitals are not fixed level, to the end that the adjection may correſpond to the epiſtylium*, imply a mutual relation and dependence between the manner of fixing the capitals, and the correſpondence of the adjection to the epiſtylium; but a correſpondence of figure, &c. between the adjection and epiſtylium can have no relation or connexion to any manner of fixing the capitals on the columns, ſo that the reaſoning would be totally incoherent; and it might as rationally be ſaid, the capitals muſt be fixed level, to the end that the foundation may be well built.

Hence the adjection alluded to cannot be that in the ſtylobatæ; it follows that it muſt be ſome other, and the order of mentioning it, as well as the uſe aſcribed to it, (which no other would anſwer), prove it to be that adjection generally uſed by the ancients on the tops of the capitals.

Thus conſidering it, we ſhall find all circumſtances agree; for there is certainly a mutual relation and dependence between the manner of fixing the capitals, and the correſpondence of ſuch adjection to the epiſtylium; for this adjection is the medium that reconciles the different levels of the beds of the capitals and the bed of the epiſtylium; and thus the reaſoning of the text becomes coherent and juſt; and the words *ſuperioribus membris* become pertinent, which otherwiſe ſeem ſuperfluous and unneceſſary.

Galiani confeſſes not to underſtand this paſſage, nor what can be meant by Vitruvius's injunction not to obſerve the level, but the *equalem modulum* only, in fixing the capitals.

The foregoing ſufficiently explains the meaning of that injunction; *viz.* that the capitals are to be ſo fixed on the columns, as to preſerve the due heighth of the columns, according to the number of modules aſſigned equal in all, preſerving the coincidence of their axes, &c. without regarding the level of the epiſtylium, or that of their own bed, which deficiency is to be rectified by the adjection or ſcamillus mentioned.

If then the above arguments are allowed to be juſt, and it is ſufficiently clear that the adjections here alluded to are thoſe generally uſed by the ancients on the tops of the capitals, whoſe nature and form are well known; it follows that thoſe in the ſtylobatæ are of the ſame kind, (for Vitruvius compares them together): and thus the long conteſted argument concerning the uſe, form, and preciſe ſituation of the ſcamilli impares will be determined.

epiſtyliums is proportionally determined; for, when the ſight is directed upward, it does not ſo eaſily penetrate the denſity of the air, but glances over the altitudinal ſpaces, and its ſtrength being impaired, it makes an uncertain judgment of the dimenſions. Wherefore a proportional addition is ever to be made to the members, when the building is ſituated high, or is of a Coloſſal magnitude. The breadth of the epiſtylium at the bottom part, which reſts upon the capital, is made equal to the thickneſs of the top of the column, juſt under the capital; and the top (of the epiſtylium) is equal to the bottom of the (ſhaft of the column.) The cymatium (D) is the ſeventh part of the heighth of the epiſtylium, and in projecture it is the ſame. The remainder, excluſive of the cymatium, is divided into twelve parts; and of theſe, the firſt faſcia (A) has three, the ſecond (B) four, and the uppermoſt (C) five. The zophorus[19*] (o p) is a fourth part leſs than the epiſtylium which it reſts on; but

(18*) Galiani, as well as Perault, obſerves, that, by this rule, in very high columns, the diminution being very ſmall, the projection of the epiſtylium (or architrave) would of courſe be too little, and therefore they ſuppoſe, that by the top of the epiſtylium ſhould be underſtood the top of its upper faſcia, excluding the cymatium. But, ſuppoſing this ſhould be the caſe, it ſtill conforms to the ſame principle of making the projectures leſs as the heighths are greater, and only transfers the rule from the top of the cymatium to the top of the upper faſcia. If this principle therefore is allowed in one part, it muſt be in another; and if it is practiſed in the faſcias, it ſhould be in the cymatium alſo. This, however, will not be the caſe in the cymatium, if we ſuppoſe it not to be included in the projecture here allowed to the epiſtylium; for, as the higher the columns are, the higher is the epiſtylium, and as the cymatium has in heighth and projecture the ſeventh part of the heighth of the epiſtylium, conſequently the projecture of the cymatium will be greater the higher the columns are, at the ſame time that the projecture of the faſcias will be leſs. This is ſo inconſiſtent, that I cannot help believing that Vitruvius certainly includes the cymatium in the projecture he allows to the epiſtylium, the rather, becauſe it is evident, that he includes the cymatium by the word epiſtylium, where he mentions its heighth, (for he ſpeaks juſt below of the remainder of the heighth of the epiſtylium, when the heighth of the cymatium is taken from it): and therefore there can be no doubt but that he includes the cymatium by the word epiſtylium, where he ſpeaks of its breadth; conſequently the top of the epiſtylium muſt mean the top of the cymatium of the epiſtylium. This argument is alſo ſtrengthened by the example of the temple of Fortuna Virilis at Rome; the projection of the cymatium conforms to the rule here given, the extremity of the cymatium being perpendicular to the bottom of the ſhaft of the column.

Nor can I think this a bad rule, or foreign to the intention of Vitruvius: for he ſays, altitudinal ſpaces are diminiſhed in appearance at great heighths, and therefore they ſhould be proportionally encreaſed; and for this very reaſon projectures in ſuch ſituations ſhould be proportionally leſſened, that they may not contribute to make the altitudinal ſpaces appear leſs; for a ſmall projecture at a great heighth, or a near view, obſtructs the ſight of a great altitudinal ſpace above it; and therefore the projecture of the epiſtylium on very high columns ought to be ſmall, in order to hide as little as poſſible of the incumbent friſe.

Theſe arguments alſo help to confirm the opinion concerning the projecture of the abacus, mentioned at note 16, foregoing, and to prove that Vitruvius does not here mean that its projecture ſhould be proportionally larger in higher columns, as all the tranſlators have rendered it, but the contrary; for the projecture of the abacus has the ſame influence on the members above it, as that of the epiſtylium has, and it is therefore moſt likely that Vitruvius would adviſe the ſame method to be obſerved in both caſes, not the direct contrary.

I am therefore of opinion that Vitruvius intends the heighth only of the epiſtylium to be altered by the variation of the heighth of the columns, and that all its projectures are to remain the ſame in all caſes, *(i. e.)* its top is to be always perpendicular with the bottom of the column.

I have given draughts of the epiſtylium according to the loweſt and higheſt proportion here mentioned. The former agrees with that of Fortuna Virilis; the latter is not quite ſo high as that of the theatre of Marcellus, which is three quarters of a diameter, whereas this amounts only to two thirds of a diameter and the twenty-fourth part; I have drawn it only two thirds, as being a proportion more conſentaneous to the other members. See Fig. XXIV. No. 3, 4, and 5.

(19*) The zophorus is that member which we call the *friſe*, o p, fig. XXIV. Vitruvius does not inform us whether or not the cymatium of the zophorus is included in the meaſure he allows to its heighth. I have repreſented it not included; and, with the proportionally loweſt epiſtylium, I have joined the proportionally higheſt zophorus that Vitruvius deſcribes, and, with the higheſt epiſtylium the loweſt zophorus; by which means the epiſtylium and zophorus together riſe to the ſame heighth in both caſes; but the cornice of the latter

if it is intended to be ornamented, it ſhould be a fourth part higher than the epiſtylium, that the ſculpture may be conſpicuous; its cymatium (E) is the ſeventh part of its heighth; the projecture of the cymatium is equal to its thickneſs.

Upon the zophorus the denticulus (v), is formed equal in heighth to the middle faſcia of the epiſtylium, and its projecture is the ſame as its heighth. The interſection, which by the Greeks is called *metoche*, is ſo ordered, that the dentil has in front the half part of its heighth, and the void of the interſection is two thirds of the breadth of the front; its cymatium is the ſixth part of its heighth. The corona (q), with its cymatium, excluſive of the ſima (x), is equal in heighth to the middle faſcia of the epiſtylium. The projecture of the corona, together with the dentil, is made equal to the heighth from the zophorus[20*] to the top of the cymatium of the corona; and all moldings in general will have the beſt effect when their projectures are made equal to their heighths.

Fig. XXIV. No. 3.

Fig. XVIII.

The heighth of the tympanum (E) of the faſtigium is thus determined: The whole front of the corona, from the extremes of the cymatium, being divided into nine parts, one of thoſe parts makes the heighth of the middle point of the tympanum. Its ſurface is perpendicular with the lower faſcia of the epiſtylium, and with the hypotrachelium of the columns. The coronæ[21*], which lye upon the tympanum, are, excepting the ſimæ, diſpoſed like thoſe below. Over the coronæ are the ſimæ (x), which the Greeks call *epitithedas*; they are made an eighth part higher than the coronæ.

Fig. XXIV.

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becomes larger, on account of its being governed by the heighth of the epiſtylium. Likewiſe, in the former caſe, for the ſake of proportion and conformity to the antique, and alſo as the difference is very ſmall, I have drawn the zophorus higher than the epiſtylium a fourth part of itſelf, inſtead of a fourth part of the epiſtylium; ſo that, in one caſe, the epiſtylium has three and the zophorus four parts; and in the other, the epiſtylium has four, and the zophorus three parts, each part being one ſixth of a diameter. I have however made no variation in the reading from the words of the text.

But if, with the higheſt epiſtylium, (I mean ſuch as is directed for columns of thirty feet high) a friſe of the higheſt proportion preſcribed is adjoined, (*i. e.* one that is a fourth part higher than the epiſtylium) then the whole entablature becomes larger than in either of the former caſes, exceeding two diameters in heighth, as the draughts demonſtrate. So that Vitruvius is miſrepreſented by thoſe maſters, who give the proportions he allows to the ſmalleſt columns, as thoſe which are to be invariably applied to columns of all magnitudes, and in all ſituations; from which miſrepreſentation Vitruvius has been unjuſtly accuſed of littleneſs, and of not allowing a ſufficient magnitude to the entablature of this order.

(20*) This muſt be underſtood, from the top of the cymatium of the zophorus, to the end that it may conform to the rule immediately after given, *viz.* of making the projectures equal to the heighths.

(21*) The word coronæ is ſometimes uſed for the whole cornice, and ſometimes for that ſingle member generally called *corona* (q Fig. XXIV.) in which latter ſenſe I think it muſt be here underſtood; for it was the practice of the Greeks to have no other member than the corona and ſima to run up the declivity of the tympan: and it is agreeable to the principle Vitruvius mentions in the ſecond chapter of the fourth book. It being alſo ſaid, that *the ſima is to be an eighth part higher than the corona*, confirms the opinion; for it cannot be ſuppoſed that Vitruvius means the ſima to be an eighth part higher than the whole cornice, that being too extravagant to be admitted.

Fig. XVIII. THE acroteriæ[22*] (a c) at the angles are as high as the middle of the tympanum; and the middle one (b) is an eighth part higher than thoſe at the angles.

ALL the members which are above the capitals of the columns, *viz.* the epiſtylium, zophorus, coronæ, tympanum, faſtigium, and acroteriæ, are to incline forward in the front the twelfth part of their heighth; for, when we ſtand oppoſite to the front, two rays diverging from the eye, one to the bottom of the work, the other to the top, that which aſcends to the top will be the longeſt; the viſual lines, therefore, that extend to the upper members being the longeſt, make the faces of thoſe members appear to lean backward; ſo that, when they are inclined forward, as above written, they then ſeem to be perpendicular and upright.[23*]

Fig. XXIV. THE ſtrigæ[24*] (L) of the columns are in number twenty-four, and are ſo excavated, that a ſquare being applied to the hollow of the ſtrigæ, and turned round, the arms of the ſquare may touch the edges of the ſtriæ to the right and left, while the point paſſes round, and touches every part of the circumference.[25*] The thickneſs of the ſtriæ is made equal to the ſwell in the middle of the column, which may be found by the deſcription.[26*]

THE ſimæ, which are upon the flanks of the temple, are to have the ſculptures of lions heads; and firſt, thoſe which are perpendicular to the ſeveral columns are to be deſigned,

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(22*) The acroteriæ are the little pedeſtals placed on the pediment, or faſtigium, to bear the ſtatues. I agree with Galiani, that the word *medium*, in the text, muſt be underſtood to refer to the middle of the heighth of the tympanum, not to the middle of its length; for, in the latter caſe, the acroters would be uſeleſsly and prepoſterouſly high. I alſo judge they are meant to be on a level with the ſaid middle of the tympanum, and not to be as high as half the heighth of the tympanum in their own proper meaſure. See c in the elevations of Fig. XIV. to XXI.

Where the elevation is broad, and the tympan of courſe high, the heighth of the acroters, according to this rule, becomes apparently too great, as may be ſeen by the acroters (c) in the ſeveral elevations above mentioned; and as, by this means, their proportional magnitude encreaſes as the breadth of the front encreaſes, (which is unneceſſary, conſidering their uſe), the rule ſeems not to be eligible, without ſome limits be fixed where the proportion ſhould vary.

I ſubmit it to the public judgment whether it might not be a good rule, to make the acroters at the angles ſo high above the top of the cornice as is equal to the projection of the cornice, whatever it may be; for, by this rule, their heighth will always be ſufficient to prevent their being hid by the projection of the cornice, if viewed at a moderate diſtance; and never too much, whatever may be the breadth of the front of the temple. I however would exclude the Tuſcan cornice, on account of its enormous projection.

(23*) In the theatre of Marcellus at Rome, the faſcias of the epiſtylium are inclined forward in the manner here directed. In caſes where the members are thus inclined, the projectures muſt ever remain the ſame, as if the members were perpendicular. This muſt undoubtedly be underſtood; for otherwiſe, the quantity of inclination in ſome parts being greater than the quantity of projecture, (as in the facias of the epiſtylium), the incumbent members in ſuch parts would appear to recede, inſtead of projecting.

(24*) Vitruvius uſes indifferently the words ſtrigæ and ſtriæ, to ſignify the flutings or channellings of the columns. Some ſuppoſe he uſes ſtriæ for the fillets or ſquares between the channels, as in this place he ſeems to do; but at the third chapter of the fourth book, he evidently applies the word ſtriæ to the channels only; for, at that place he is ſpeaking of the Doric channels, which have no fillets between them.

(25*) This is as much as to ſay, the channels are to be made ſemicircular; for the elbow of a ſquare revolving between two points, the two arms continuing all the while to touch both the ſaid points, deſcribes a ſemicircle.

(26*) The thickneſs of the fillets are about the thirtieth part of the diameter of the column. See note 11, at the ſecond chapter of this book.

the reſt are diſpoſed equidiſtantly, in ſuch a manner, that each may anſwer to the middle of each reſpective tile.[27*] Thoſe which are over the columns are to be perforated, for a channel to convey the rain-water from the tiles; but thoſe which are between are imperforate, that the water may be diſcharged from the tiles by the proper channels, and not fall in the intercolumns, nor overflow the paſſengers: ſo that the lions heads, which are over the columns, ſeem to diſgorge the water from their mouths. Thus I have, in this book, deſcribed, as well as I have been able, the conſtruction of Ionic temples. The proportions of the Doric and Corinthian kind I ſhall explain in the following book.

(27*) Perault thinks this ſhould not be underſtood each tyle, but *each water channel*, made in the roof; and Galiani thinks it ſhould be read *the middle channel*: but the text clearly enough expreſſes each tile, and I cannot ſee any abſurdity in ſuppoſing the ancient tyles were ſo large as to be equal to the diſtances between the lions heads; for in ſome parts of Italy, at this day, tiles of ſuch a magnitude are uſed as is equal to the diſtances that may be ſuppoſed to have been between the lions heads; and in the Tower of the Winds at Athens, this rule is fully exemplified, the middle of the tiles coinciding exactly with the middle of the lions heads in the ſima.

The breadth of the lower range of tiles in this tower is two feet eleven inches, though the diſtance from center to center of the heads is three feet ten inches, owing to the divergence of the radial lines. Suppoſing, however, two feet eleven inches, or even two feet ſix inches, or leſs, to have been the ſize of the ancient tyles, and conſequently the diſtances of the lions heads from each other, this meaſure will be ſufficiently large to admit us to ſuppoſe, that a head might have been placed oppoſite to each tyle; for, allowing only the number of two heads to happen in the intercolumns, (and leſs cannot be allowed, for Vitruvius ſpeaks of them in the plural) the centers of the columns may be ſeven, eight, or nine feet apart; which is a ſufficient and ample diſtance for moderately large temples of the pycnoſtyle or ſyſtyle kinds.

THE END OF THE THIRD BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE FOURTH.

PROEM.

As I have obſerved, O Emperor! many treatiſes of architecture, and books of commentaries, undertaken without method, and executed in ſuch a manner, as to omit various articles, I judged it proper and uſeful to reduce the ſubſtance of this work to a regular order, and, in the ſeveral books, to explain the nature of the ſeveral things herein written. I have therefore, O Cæſar! in the firſt book, explained to thee the qualifications of an architect, and the knowledge he ſhould poſſeſs. In the ſecond, I have diſcourſed on the materials of which buildings are conſtructed. And, in the third, of the compoſition of ſacred edifices, of their various kinds and ſpecies, and of their diſtribution according to their ſeveral kinds. Of the three orders which have preciſe modulary proportions, the Ionic I have already taught; in this book, therefore, I ſhall ſpeak of the Doric and Corinthian, and of their differences and properties.

CHAPTER I.

Of the three Kinds of Columns, and of their Invention.

Fig. XXIII. CORINTHIAN columns, excepting in their capitals, have their ſymmetry the ſame as the Ionic; but the heighth of the capital renders them proportionally taller and more graceful; for the heighth of the Ionic capital is only a third part of the thickneſs of the column[1*]; whereas that of the Corinthian is the whole thickneſs of the ſhaft: wherefore, as two thirds of the thickneſs of the column are added to the capitals of Corinthian columns, it cauſes them to appear higher and more graceful. The other members which are placed above the columns, are taken from the Doric or Ionic orders, and diſpoſed over Corinthian columns: for the Corinthian has no cornice, or other ornaments peculiar to itſelf, but has either triglyphs, mutules in the cornice, and guttæ in the epiſtylium, as in the Doric manner; or elſe, according to the Ionic manner, the zophorus is ornamented, and dentils are diſpoſed in the cornice.[2*] So that by theſe two orders, joined with a different capital, a third order is produced; for, from the formation of the three kinds of columns, ariſe the denominations, Doric, Ionic, and Corinthian; of which the moſt ancient and firſt invented is the Doric; for, when Dorus, the ſon of Hellenus and the nymph Opticos, reigned over all Achaia and Peloponneſus, the temple of Juno, in the ancient city of Argos, was erected, and this order happened to be uſed in the fane. The ſame order was alſo uſed in the other cities of Achaia, before the laws of its ſymmetry were eſtabliſhed.

AFTERWARD, when the Athenians, according to the reſponſes of Apollo of Delphos, and the common conſent of all Greece, tranſplanted, at one time, thirteen colonies into Aſia, appointing to every colony a leader, they gave the chief command to Ion, the ſon of Xuthus and Creuſa, whom alſo the Delphian Apollo acknowledged for his ſon. Theſe colonies he conducted to Aſia, ſeized on the territory of Caria, and there founded many large cities, as, Epheſus, Miletus, Myunta, (which laſt was formerly overflown with water, and its rites and privileges, by Ion, transferred to the Mileſians) Priene, Samos, Teos, Colophon, Chios, Erythræ, Phocis, Clazomenæ, Lebedus, and Melite. This latter, on account of the arrogance

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(1*) Reckoning from the top of the abacus to the bottom of the echinus, not to the bottom of the volute. Vitruvius therefore allows the Corinthian ſhaft to be of the ſame heighth as the Ionic ſhaft, and the whole column, including baſe and capital, two thirds of a diameter higher than the Ionic; that is, nine diameters and a ſixth.

(2*) This accounts for the differences found in the antique examples of the Corinthian order, which the ancients deemed a compound order.

of the citizens, was deſtroyed in the war declared againſt it, by the unanimous determination of the other cities, and, in its place, by the favour of King Attalus and Arſinoe, the city of Smyrna was received amongſt the Ionians. When theſe cities extirpated the Carians and Leleges, they, from their leader Ion, called that territory *Ionia*.

THERE they began to erect fanes, and conſtitute temples to the immortal Gods. Firſt, they erected the temple of Apollo Panionios, in the manner they had ſeen it in Achaia; which manner they called *Doric*, becauſe they had ſeen it firſt uſed in the Dorian cities. In this temple they were deſirous of uſing columns; but being ignorant of their ſymmetry, and of the proportions neceſſary to enable them to ſuſtain the weight, and give them an handſome appearance, they meaſured the human foot, and finding the foot of a man to be the ſixth part of his heighth, they gave that proportion to their columns, making the thickneſs of the ſhaft at the baſe equal to the ſixth part of the heighth, including the capital. Thus the Doric column, having the proportion, firmneſs, and beauty of the human body, firſt began to be uſed in buildings.

AFTERWARD, to conſtruct the temple of Diana, they ſought a new order from the ſame traces, copying the gracefulneſs of women, and making the thickneſs of the columns an eighth part of their heighth, in order to give them a taller appearance. The folds of the baſe they deſigned for the ſhoe; the volutes of the capital for the treſſes of hair, dropping to the right and left; the cymatium and encarpi[3*], for the locks diſpoſed to ornament the forehead; and the channels of the ſhaft for the plaits of the matrons garments. Thus aroſe the invention of theſe two different orders; one of a maſculine appearance, naked and unadorned; the other imitating the ſlenderneſs and fine proportion of women. But poſterity, improving in ingenuity and judgment, and delighting in more graceful proportions, fixed the heighth of Doric columns at ſeven times their diameter; and of the Ionic, at eight and a half. This latter order was called Ionic, becauſe it was firſt uſed by Ion.

THE third, which is called *Corinthian*, is in imitation of the delicacy of virgins; for, in that tender age, the limbs are formed more ſlender, and are more graceful in attire. The capital is reported to have been thus invented: A Corinthian maid, juſt marriageable, being ſeized with a diſorder, died: after her interment, her nurſe collected, and diſpoſed in a baſket, the toys which pleaſed her when alive, carried it to the tomb, placed it on the top, and, that it might endure the longer in the open air, covered it with a tyle. The baſket chanced to be placed over the root of an acanthus, which, being thus depreſſed in the middle, the leaves and ſtalks, in the ſpring ſeaſon, iſſued outward, and grew round the ſides

(3*) Encarpi alludes to ſome ornaments in the Ionic capital; but which it preciſely means is doubtful; ſome take it for the feſtoons hanging from the eyes of the volutes; others for the pods, which ſpring from the volutes, and cover the angles between them and the ovolo; and others again for the foliage in the channel under the abacus. It may alſo mean the carving of the abacus, or flower in the middle of the ſame, as moſt reſembling the locks on the forehead.

of the baſket; and, being preſſed by the weight at the angles of the tyle, were made to convolve at the extremities, like volutes. At that time Callimachus, who, for his ingenuity and excellence in the arts, was, by the Athenians, named *Catatechnos*,[4*] happening to paſs by this tomb, took notice of the baſket, and being pleaſed with the delicacy of the foliage growing around it, as well as the novelty of the form, made ſome columns near Corinth, according to this model, and from thence eſtabliſhed the ſymmetry, and determined the proportions of the Corinthian order.

Fig. XXIII. The ſymmetry of this capital is thus performed. The heighth of the capital (a c), including the abacus, is to be equal to the thickneſs of the column at bottom. The breadth of the abacus is ſo regulated, that its diagonal, from angle to angle (d d), may be twice as much as the heighth of the capital; for this gives a proper dimenſion to each face. The fronts of the abacus are bowed inwardly (g i), from the extreme angles (d f), a ninth part of its breadth.[5*] The bottom of the capital is as thick as the top of the column (h), without the apotheſis[6*] (n) and aſtragal (o). The thickneſs (a m) of the abacus is the ſeventh part of the heighth of the capital. The remainder, when the thickneſs of the abacus is deducted, is divided into three parts, of which one is given to the lower leaves; the ſecond is for the heighth of the middle leaves, and to the caulicules or ſtalks, from which leaves project, ſo as to ſupport the abacus, the ſame heighth is given. From theſe caulicules the volutes ſpring, projecting to the extreme angles; and the leſſer helices (k) are wrought under the flowers, which are in the middle of the fronts of the abacus. The flowers on the four ſides, are, in ſize, equal to the thickneſs of the abacus. Thus the Corinthian capital will have its proper ſymmetry.

There are alſo other kinds of capitals, called by various names, which are diſpoſed on the ſame columns, and which have no proper ſymmetry, or relation to any order of columns that can be named differently; but they are all derived and transferred from the Corinthian, pulvinated, or Doric orders, from whoſe ſymmetries they differ only in the little novelties of the ſculpture.

(4*) Catatechnos, the firſt of artiſts.

(5*) Vitruvius ſays nothing of obtunding or cutting off the corners of the abacus, as generally practiſed by the ancients as well as moderns: from whence we are led to believe, that the ſides of the abacus of the Corinthian capital, according to Vitruvius, ſhould terminate in four acute angles, as (d d) Fig. XXIII. Of this kind are the capitals of the Temple of Veſta, at Rome, and thoſe of the Poikile, or Stoa, at Athens.

(6*) Apotheſis is the ſmall ſquare, or fillet, under the aſtragal at the top of the column; at the ſeventh chapter of this book it is called apophygis.

CHAPTER II.

Of the Ornaments of Columns.

AS the origin and invention of the ſeveral orders of columns are above deſcribed, it ſeems to me not improper to ſpeak alſo of the origin of their ornaments,[o*] and of the principles from which they were derived.

Fig. XXVIII. IN the upper part of all edifices, timbers, called by various names, are diſpoſed, which, as in names, ſo in uſes, differ. The trabs[1*] (e) are thoſe laid over the columns, paraſtatæ, and antæ, in the contignations and floors. If the ſpan of the roof is great, under the culmen (m), in the top of the faſtigium, are diſpoſed columens (a), from whence columns derive their name, tranſtræ (b), and capreols (d); but if the ſpan is ſmall, columens and canthers (c), projecting to the extremities of the eaves. Above the canthers are the templats (f); and over them, but under the tyles, are the aſſers (g), projecting ſo far as to ſhelter the walls. Thus each, according to its uſe, has its proper place and order.

(o*) By the word ornaments is to be underſtood entablatures, Vitruvius expreſſing them by that appellation.

(1*) I have adhered to the Latin names of the timbers, in order to preſerve a ſimilarity between the reading of the text and of the tranſlation, and to give the reader a better opportunity of making his own judgment of the timbers meant by thoſe names, mentioning my own opinion thereon in the notes.

The trabes, or beams, are undoubtedly the plates, or raiſing plates, as our workmen call them; being the timbers that are laid upon the ſummit of the walls, columns, &c. receiving the preſſure of the roof, and diſtributing it equably over the ſupports. From this timber, the architrave, or epiſtylium, is derived, e e Fig. XXVIII.

The column, or columen, I conceive to be that upright piece (a a), by us called king-poſt, which is ſituated perpendicularly under the ridge of the roof, deſcending from thence to the tigna h, or croſs beam, below. Some have taken it for the horizontal piece in the ridge, called the ridge piece, (m m) and which, Vitruvius, in this place, as well as in the firſt chapter of the fifth book, calls culmen.

The name of columns, being derived therefrom, is a circumſtance that favours the ſuppoſition of its being a perpendicular piece; and the king-poſt, which is a principal and neceſſary part of a large roof, and the mention of which is to be expected, in a deſcription of the timbers of a roof, is no where elſe mentioned.

The tranſtræ I was about to accept, as others have done, for the horizontal beams, h h that lay croſs the building, holding together the oppoſite walls, when I obſerved that thoſe croſs beams are mentioned in the next paragraph by the general name of tignæ: and it is ſaid that the tranſtræ are uſed in large roofs only, not in ſmall. Alſo in the deſcription of the Baſilica of Fano (Chap. I. Book V.) Vitruvius mentions tranſtræ ſupporting the culmen, where it is evident no ſuch horizontal beams can be uſed, on account of the vault of the cieling riſing into the angle of the roof; and where thoſe who have ſuppoſed the tranſtræ to be the horizontal beams have repreſented no ſuch beams; and conſequently no tranſtræ, although Vitruvius expreſsly mentions them. From theſe circumſtances, I judge the tranſtræ to be the principal rafters (b b); for thoſe rafters, and the braces, or capreols (d) as well as the king-poſt (a) are (as Vitruvius ſays) uſed only in large roofs, not in ſmall; and are neceſſary, not only on account of the magnitude of the roof, but on account of the projecture of the ſmall rafters beyond the ends of the tignæ (in the ſame manner as the mutules project beyond the triglyphs;) and which could not happen without the aſſiſtance of ſuch principal rafters to ſupport them I do not ſuppoſe theſe tranſtræ, or principal rafters, to have been uſed at every tigna, but at proper diſtances.

The capreols are univerſally allowed to be the ſtruts, or braces (d d.)

The canthers are evidently the common rafters (c c); for Vitruvius ſays, the declination of the mutules are in imitation of the inclined poſition of the canthers. I have purpoſely avoided drawing the canthers ſo broad in proportion as the mutules are generally repreſented.

The templats are the croſs pieces (f f) ſerving to ſupport the aſſers in the ſpaces between the canthers.

The aſſers ſeem to be ſmall pieces ranged very cloſe, in order to ſupport the tiles; for Vitruvius ſays, they laid between the templats and the tiles; and the dentils are in imitation thereof.

This diſpoſition of the work, the artificers, when they erected ſacred edifices, imitated in ſculptures of ſtone and marble; and this invention the ancient workmen thought proper to purſue. Thus, whenever they conſtructed any building, they laid the joiſts from the interior walls to the extreme parts, then built up the interjoiſt (k), and, to give the work a pleaſing appearance, adorned the top with a cornice and faſtigium; then, as much of the joiſts as projected beyond the wall they ſawed off; which appearing unhandſome, they made tablets (h), like the triglyphs now in uſe, fixed them againſt the ſawed ends of the joiſts, and painted them in wax, that the ſections of the joiſts might not offend the ſight. Thus the triglyphs, interjoiſts, and opæ[2*], in Doric work, had their origin from the diſpoſition of the timbers of the roof.

Afterward, in other works, ſome made the canthers, that were perpendicularly over the triglyphs, to project outward, and carved their projecture; hence, as the triglyphs aroſe from the diſpoſition of the joiſts, ſo the mutules under the corona were derived from the projecture of the canthers: wherefore, in ſtone or marble ſtructures, the mutules are repreſented declining, in imitation of the canthers; and alſo, on account of the droppings from the eaves, it is proper they ſhould have ſuch declination.

From this imitation, therefore, aroſe the uſe of triglyphs and mutules in Doric work: for it cannot be, as ſome erroneouſly aſſert, that the triglyphs repreſent windows; becauſe triglyphs are diſpoſed in the angles[3*], and over the quarters[4*] of the columns, in which places windows are not permitted; for if windows were there left, the union of the angles of buildings would be diſſolved; alſo, if the triglyphs are ſuppoſed to be ſituated in the place of the windows, by the ſame reaſon, the dentils in Ionic work may be thought to occupy the places of the windows; for the intervals between the dentils, as well as between the triglyphs, are called *metopæ*; the Greeks calling the bed of the joiſts and aſſers, *opas*, (as we call it *cava, columbaria)*; ſo becauſe the interjoiſt is between two opæ, it is by them called *met-opæ*. As the triglyphs and mutules in the Doric order are founded upon theſe principles, ſo the dentils, in the Ionic, derive their proper origin from the workmanſhip; and as the mutules repreſent the projectures of the canthers, the dentils in the Ionic order are in imitation of the projecture of the aſſers. For this reaſon, in Grecian buildings, dentils are never placed under the mutules; for aſſers cannot be under canthers. As therefore they ſhould in reality be above the canthers and templats, if they are repreſented below them, the work is on falſe principles. The ancients likewiſe did not approve of placing mutules or dentils in the faſtigium, but the

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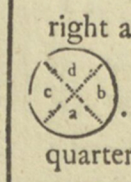
(2*) Opæ is explained farther on in this chapter.

(3*) In the ruins of the Grecian buildings at Athens, and alſo in ſome at Pœſtum, in Italy, we find the triglyphs placed cloſe to the angles, not perpendicularly over the middle of the columns, as practiſed in the Roman as well as modern architecture.

(4*) By this expreſſion we are to underſtand the middle of the columns; for the quarters of the columns, I ſuppoſe, mean the four parts of the column, when divided on the plan, by two diagonal lines paſſing through the center at right angles to each other, in the form of a croſs, thus, 

. In the next chapter Vitruvius calls them the middle quarters, which are the two quarters a and d in the middle of the front and rear of a column ſo divided, having the two other quarters b and c on either ſide them.

corona only; becauſe, neither canthers nor affers are laid toward the front of the faſtigium, nor can they there project, for they are laid inclining toward the eaves. As, therefore, it could not be done in reality, they judged it not proper to be done in repreſentation; for the propriety of all things, which they introduced in works of perfection, they derived from truth and nature; and approved thoſe only which could bear the teſt of rational argumentation. From theſe principles they eſtabliſhed the ſymmetry and proportions of each order; of which, purſuing the deſcription, and having ſpoken above of the inſtitution of the Ionic and the Corinthian, I ſhall now briefly explain the proportion and formation of the Doric.

CHAPTER III.

Of the Doric Order.

SOME architects have maintained, that temples ſhould not be built of the Doric order, becauſe it occaſions an imperfection and an inconvenience in the ſymmetry; for this reaſon it was rejected by Tarcheſius, Pytheus, and alſo by Hermogenes: the latter, after he had prepared marble materials for a Doric temple, altered them, and from the ſame materials raiſed an Ionic temple to Bacchus. However, it was not becauſe the appearance was unhandſome, or the manner or form ignoble; but becauſe it impeded the diſtribution, and the arrangement of the triglyphs and lacunars[1*] was unſuitable to the deſign; for it is neceſſary that the triglyphs ſhould be diſpoſed over the middle quarters of the columns; the metops, which are between the triglyphs, be made as long as high; and the triglyphs over the angle columns be placed at the extremities, and not over the middle quarters. So that the metops which adjoin the angular triglyphs, are not ſquare, but more oblong by half the breadth of a triglyph.[2*] Thoſe who would make all the metops equal, contract the extreme intercolumn

(1*) The lacunars are the coffers or pannels uſually formed in the ſoffites of the corona, or architrave, as well as in the cielings, &c.

(2*) Galiani, as well as Perault, remarks, that the metop is not encreaſed quite half the breadth of a triglyph, but leſs than half, by as much as the ſemi-diminution of the column. This is not the fact; they have not recollected the lateral projection of the triglyph from the face of the friſe, but have ſuppoſed the outer edge of the angular triglyph to be perpendicular with the top of the ſhaft of the column; whereas, according to the rule of Vitruvius here given, the ſaid outer edge will ever be perpendicular to the bottom of the ſhaft, which was the conſtant practice of the Greeks; ſo that the extreme metop was encreaſed half the breadth of a triglyph exactly, and the projection of the triglyphs was the only thing varied by the various diminution of the columns.

The projection of the triglyphs will by this rule be leſs, in proportion as the column is taller, and leſs diminiſhed; which is agreeable to the remark made at the third chapter of the third book.

The method of placing the outer edge of the angular triglyphs perpendicular to the bottom of the ſhaft of the column, was generally practiſed by the Greeks, as is proved by all the examples of Grecian temples now remaining; but they made the face of the epiſtylium alſo in the ſame perpendicular; whereas Vitruvius directs this latter to be perpendicular to the top of the ſhaft, and, (as may be inferred from the context) the face of the friſe or metop alſo. See note 4* enſuing.

half the breadth of a triglyph; but this, whether it is done by lengthening the metop, or by contracting the intercolumn, is a defect. On this account, the ancients avoided the uſe of the Doric order in ſacred edifices. Following however our method, we ſhall give the explanation of this order, as we have received it from the maſters; ſo that thoſe who attend to theſe precepts will here find deſcribed the rules by which they may erect a temple in the Doric manner, without fault or imperfection.

Fig. XIV. and XV. The front of the Doric temple, where the columns are erected, is, if tetraſtyle, divided into XXVIII parts; if hexaſtyle into XLIV.[3*] Of theſe parts one will be a module, called in Greek *embates*, by which the diſtribution of the whole work

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(3*) The numbers 28 and 44, which are found in the manuſcripts, have been altered by all the tranſlators to 27 and 42; they ſuppoſing the former two numbers to have been erroneous, and to have ariſen from the miſtake of the copyiſts; becauſe, upon computing the number and meaſure of triglyphs and metops afterward deſcribed in the front, the latter numbers are produced.

Their manner of computation is as follows: In the tetraſtyle temple is 11 triglyphs, at one module each, and 10 metops at a module and a half each; which together make 26 modules; and that, added to half a module at either end, amounts in all to 27 modules.

In the hexaſtyle temple is 17 triglyphs and 16 metops; which, according to the meaſures abovementioned, make 41 modules, and 1 module being added for the ſemi-metops at the angles, it amounts in the whole to 42 modules.

But, upon reflecting on the facility of the computation, the general agreement of the copies, and the improbability of ſo evident an error being generally and uniformly continued, I was induced to ſuſpect, that the ſource of this diſagreement lay in ſome other tract.

Purſuing this thought, and obſerving that Vitruvius (a little farther) ſays, this diſpoſition is for diaſtyle work, I tried the computation according to that ſpecies of intercolumniation, and found it exactly agreed therewith; the numbers, as generally wrote in the text, happening right in both inſtances. Thus, in the tetraſtyle temple, the two lateral intercolumns, at 3 diameters, or 6 modules each, is 12 modules; the middle intercolumn to contain three triglyphs muſt be 8 modules; and the four columns, at 2 modules each, is 8 modules; which altogether make 28 modules, the number of the text. So, in the hexaſtyle temple, the four lateral intercolumns, at 6 modules each, is 24 modules; the middle one 8, and the ſix columns 12; which in all make 44 modules, as in the text. But, in this caſe it will happen that the metops in the lateral intercolumns will be a ſixth part of a module longer than a module and a half, the meaſure generally allowed them; and, on the other hand, if the metops are computed no more than a module and an half, the lateral intercolumns will be half a module leſs than three diameters, the juſt meaſure of diaſtyle work. It may be ſaid, that the deduction of half a module does not change the ſpecies of intercolumniation; but I anſwer half a module changes euſtyle to ſyſtyle; and, if a ſmall difference from the preſcribed meaſure may be allowed in the intercolumns, it may alſo, with as little impropriety, be allowed in the metops.

The differences in the proportion of the metops that may be obſerved in the ſeveral Grecian ruins, in thoſe at Pœſtum, and in other remains of antiquity, make it appear, that the ancients did not ſcrupulouſly adhere to the rule of giving the metops a module and a half preciſely, or to making them exactly ſquare.

In a Doric temple, at Cora in Italy, publiſhed by Piraneſi, the metops of the ſide and middle intercolumns are not of the ſame breadth; alſo, in ſome ancient examples, the capital of the triglyphs is included in the module and half, and in others it is excluded; it is ſometimes continued through the metop, and ſometimes diſcontinued.

Nor does Vitruvius poſitively fix the heighth of the metops, but only ſays, they are as high as long. The heighth of the triglyphs did not always determine that of the metops, which ſometimes roſe higher than the triglyphs, breaking into the capital or large band above them.

In the preſent caſe, the extraordinary length of the metop is exactly equal to the heighth of the capital of the triglyph (each being the ſixth part of a module), ſo that ſuppoſing that member to be included in the heighth of the metops, they perfectly agree with the words of Vitruvius, in being exactly as long as high.

The agreement, therefore, of the numbers of the text, with the ſpecies of intercolumniation mentioned, makes it highly probable that Vitruvius intended the metops to be of ſuch a length, diſregarding the ſmall differences in their meaſures, as not being conſiderable enough to offend the eye; and that conſequently the numbers, as generally found in the manuſcripts, are perfectly right, and as intended by the author.

is regulated. The thickneſs of the columns is two modules; the heighth, including the capitals, fourteen. The thickneſs of the capital (a c) one module; the breadth (a b) two and the ſixth part of a module. The thickneſs of the capital is divided into three parts, of which one is for the abacus (d) with its cymatium; another for the echinus (f) with its annules; and the third for the hypotrachelion (h.) The columns are diminiſhed in the ſame manner as deſcribed for Ionic columns in the third book.

Fig. XXVI.

The heighth of the epiſtilium (e) with the tenia (g) and guttæ (i) is one module. The tenia is the ſeventh part of a module. The length of the guttæ, under the tenia, coincides with the perpendicular of the triglyphs. Their heighth, with the regula, (k) is the ſixth part of a module. The breadth of the bottom of the epiſtylium anſwers to the hypotrachelion at the top of the columns.

Upon the epiſtylium, the triglyphs (ll), having the metops (m) between them, are placed; being one module and a half high, and one module broad in front; they are ſo diſtributed, that thoſe which happen over the angle, as well as over the intermediate columns, may be perpendicular to the middle quarters thereof; two are left in the intercolumns; and in the middle intercolumn of the pronaos and of the poſticus, three; for, by this enlargment of the middle interval, the approach to the image of God is rendered more commodious and free from impediment.

The breadth of the triglyph is divided into ſix parts; of which, five are placed in the middle, two and a half being on either ſide. The middle one makes the regula or femur (n), which the Greeks call *meros*. On either ſide this, are the channels, ſunk as if imprinted with the elbow of a ſquare. To the right and left of theſe, another femur is formed, and at the extremities ſemi-channels are ſlanted.

The triglyphs being thus diſpoſed, the metops, which are between the triglyphs, are as high as long. At the extreme angles, ſemi metops are impreſſed, half a module broad.[4*]

(4*) It is to be remembered that Vitruvius makes his diviſions on the line whereon the columns are erected, and includes in the extent of that line the whole ſhaft of the angle columns; when, therefore, all the triglyphs and metops are adjuſted according to the directions given, at either end of that line will remain a ſpace equal to half a module. This is the meaning of Vitruvius, and not that the ſpace left at the angles at the heighth of the friſe will be half a module, as it has been uſually underſtood by the tranſlators; for, on account of the diminution of the ſhaft of the columns, the ſpace at that height will be leſſened.

Vitruvius has given us no information concerning the projection of the triglyphs from the face of the metops. In the Greek works, the face of the triglyph is always found to be perpendicular with the face of the epiſtylium, and the metop recedes; but in the Roman works, as in the theatre of Marcellus, and the Doric temple of Cora, the faces of the metops are perpendicular with the face of the epiſtylium, and the triglyphs project. For want of inſtruction, therefore, with regard to the quantity of the triglyphs projection, I ſhall follow the example of the theatre of Marcellus, in which it is nearly equal to the twentieth part of the diameter of the column.

Thus the metops, intercolumns, and lacunars, being regularly diſtributed, all defects will be avoided. The capital (p) of the triglyph is made the ſixth part of a module.[5*]

OVER the capital of the triglyphs is placed the corona (q), projecting the half and the ſixth part of a module,[6*] having a Doric cymatium[7*] (v) below, and another (v) above. The thickneſs of the corona, with the cymatiums, is half a module.[8*] In the under part of the corona, perpendicular to the triglyphs, and to the middle of the metops,[9*] the directions of the viæ[10*] (z), and the diſtribution of the guttæ (i), are to be ſo contrived, that there may be ſix guttæ in length, and three in breadth. The remaining ſpaces (y), the metops being broader than the triglyphs, are left plain, or have the ſculptures of thunder-bolts. Near the edge of the ſame corona, a line is enchaſed, which is called *ſcotia*[11*] (ʌ). The tympan, ſima, coronæ, and the reſt, are executed in the ſame manner as has been deſcribed for the Ionic order.

Fig. XVII. THE foregoing is the method for compoſing diaſtyle works; but, if the ſtructure is to be made ſyſtyle and monotriglyph,[12*] the front of the temple, if tetraſtyle, is divided into XXIII parts; if hexaſtyle, into XXXV. Of theſe one part will be a

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(5*) Whether the capital of the triglyphs is included or excluded from the module and half, allowed to their heighth, Vitruvius leaves uncertain; neither will the ancient examples help to determine it; ſome having it included, and others excluded.

(6*) Vitruvius does not inform us whether or not this projection of the corona is excluſive of the projection of the cymatiums; but judging from the examples of antiquity, and the ſpace the guttæ in the ſoffite require, I think it ſhould be underſtood to be excluſive. The projecture of the corona in the theatre of Marcellus is much greater.

(7*) Cymatium, in a general ſenſe, ſignifies a ſubordinate moulding of any ſhape that relates to one of the principal members; what particular moulding is meant by the Doric Cymatium is not known.

(8*) Galiani has juſt before reproved Perault for having deviated from the text, by altering the projection of the Doric capital; and here (ſo unfortunate we are) has himſelf fallen into a ſimilar error, having in his tranſlation taken the liberty to add a ſixth part of a module to the half module, which the text allows to the thickneſs of the corona; giving for reaſon, the general rule preſcribed by Vitruvius, that the heights ſhould be equal to the projectures; and his own opinion, that the cornice wants that increment. But theſe are not ſufficient reaſons for deviating from the expreſs direction of the text twice repeated; and (turning his own argument againſt himſelf) as the projecture preſcribed by the text, is not impracticable. Therefore, although I have a due value for his opinion in general, I think it not proper in this caſe to follow his example.

(9*) Vitruvius directs mutules to be made over the metops as well as over the triglyphs. This is ſo contrary to the cuſtom of the moderns, that none of the preceding tranſlators have underſtood the paſſage; not believing it could poſſibly have that meaning: but ſince the remains of the Grecian buildings have become known to us, we are no longer doubtful of its being the author's intention that mutules ſhould be made over the metops as well as over the triglyphs, (as fig. XXVI. ſhews.) This alſo clears the ſucceeding paſſage, *reliqua ſpatia quod latiores ſunt metopæ quam triglyphi*, which has much puzzled the commentators, and which they have all underſtood and explained, by their draughts, in a manner different to each other.

(10*) The Viæ, I conceive to be the intervals or ſpaces between the guttæ; and that they are ſo called becauſe they reſemble the viæ, or ſtreets, about the iſlands of houſes in a city. Galiani ſuppoſes them to be the margins of the pannels in the ſoffite of the corona.

(11*) This is a groove made to check the rain water.

(12*) Monotriglyph ſignifies that manner which has only one triglyph in the intercolumns.

If the metops are allowed to be no more than a module and a half broad, the intercolumns can be no more than a diameter and half wide. Wherefore, it has been generally ſuppoſed that *ſyſtylon* has been wrote, by miſtake, inſtead of *pycnoſtylon*, to which Galiani has altered the text. This point will be diſcuſſed in the following notes.

module, by which the work is to be regulated as before written. Then over every epiſtylium,[13*] two metops and triglyphs[14*] are diſpoſed. In the angles this (ſpecies) is larger (than the former) by as much as the ſpace of the biſected hemitriglyph.[15*] So that there happens in the middle epiſtylium, under the faſtigium, the ſpace of three triglyphs and three metops,[16*] for the

(13*) It has been before obſerved, that Vitruvius, in ſome places, conſiders each ſtone of the entablature that lays from center to center of column as a ſeparate epiſtylium; as d e and e f, Fig. XVI.

(14*) This paſſage has been generally miſunderſtood and miſcorrected, by the editors and tranſlators, to two metops and one triglyph. De Laet and Galiani, following the correction of Philander, have thus given the text, *metopæ duæ & triglyphi ſinguli*, inſtead of *metopæ & trigliphi bini*, as the manuſcripts expreſs it.

It muſt be noted, that in deſcribing this monotriglyph work, Vitruvius does not previouſly mention the triglyphs over the columns, as he has done in the deſcription of the diaſtyle work. It is therefore neceſſary that he ſhould, by ſome means, mention and include them, as well as thoſe over the intercolumns. This he does, by deſcribing two metops and two triglyphs over each epiſtylium; for from center to center of column is two metops, one whole triglyph and two hemitriglyphs, which make two of each. Thoſe who read but one triglyph ſuppoſe no mention to be made in the text of thoſe over the columns; which are, however, neceſſary to complete the number of modules which they themſelves aſſign to the front of the temple.

(15*) Here is another erroneous alteration of the text, derived from the miſtaken correction of Philander, and adopted by all the other editors. They read, *in angularibus non amplius quam quantum eſt ſpatium hemitriglyphi*, inſtead of *in angularibus, hoc amplius quantum dimidiatum, eſt ſpatium hemitriglyphi*, which I find in four manuſcripts: and Philander has given it as the current text. This latter reading is perfectly juſt; for, as the manner of numbering the triglyphs and metops in this ſyſtyle work, is from center to center of column, there muſt conſequently be a hemitriglyph left unaccounted over the angle columns; by which it happens that the ſpace to be added at the angles is larger than in the former caſe, (that is, than in the diaſtyle work) by as much as that biſected hemitriglyph; and thus it it expreſſed by the latter reading: whereas the former reading, which is the falſe correction, expreſſes only, that a hemitriglyph is left at the angles; as in the former inſtance, which is a defective and erroneous explication; for there remains at the angles a hemitriglyph more than in the former inſtance.

But I find this whole paſſage ſo different from that in the common editions, that it may not be improper to tranſcribe it, *ita ſupra ſingula epiſtylia & metopæ & triglyphi bini erunt collocendi: in angularibus, hoc amplius, quantum dimidiatum eſt ſpatium hemitriglyphi, id accedat in mediano, habens cymatium Doricum in imo, alterum in ſummo, item cum cymatiis corona craſſa ex dimidia, dividende autem ſunt in corona ima ad perpendiculum contra faſtigium trium triglyphorum & trium metoparum ſpatium diſtabit, quod latius medium intercolumnium accedentibus ad ædem habeat laxamentum & adverſus ſimulacra Deorum aſpectus dignitatem. Columnas autem ſtria, &c.* which runs thus in tranſlation, Over every epiſtylium, metops, and triglyph two of each are diſpoſed. In the angles this (ſpecies) is larger (than the former) by as much as the ſpace of the biſected hemitriglyph; ſo that it happens, in the middle epiſtylium (the corona having a Doric cymatium below and another above, and being, with the cymatiums, half a module thick) that the ſpace under the corona perpendicular to the faſtigium, is divided into three triglyphs, and three metops; for the middle intercolumn being enlarged, renders the entrance of the temple more ſpacious, and gives an appearance of dignity towards the ſtatue of the God.

(16*) Again, where the manuſcripts have *trium triglyphorum & trium metoparum*, Philander would have *duorum triglyphorum & trium metoparum*, or *trium triglyphorum & quatur metoparum*; which laſt, De Laet, Barbaro, Perault and Galiani have adopted. But, as it has been before ſhewn that Vitruvius computes from center to center of column, the number of triglyphs and metops muſt of courſe be equal. Therefore, the original reading is more probably right; and we ſhall find, by the following obſervations, that it perfectly agrees with the other circumſtances of the context.

I come now to ſpeak of the other two numbers, viz. XXIII and XXXV, which have been changed by ſome to *nineteen and a half*, and *twenty-uine and a half*, by others to *twenty-two* and *thirty-two*. I deferred ſpeaking of theſe till after the preceding notes, that what is ſaid thereon may be the better underſtood. Proceeding to prove theſe numbers in the ſame manner as the former two, I firſt premiſe that Vitruvius intitles this Syſtyle work; and, as he preſcribes but one triglyph in each intercolumn, the metops are conſequently two modules in breadth. Therefore, in the tetraſtyle temple, the four columns and two latteral intercolumns make 8 diameters. The middle intercolumn, to contain the given number of triglyphs and metops of the ſame dimenſions, will require to be $3\frac{1}{2}$ diameters; which, added to the former 8, make in all $11\frac{1}{2}$ diameters, or 23 modules, exactly the number mentioned by Vitruvius. It may alſo be computed by the number of triglyphs and metops: thus, eight triglyphs, at one module each, is 8 modules; ſeven metops, at two modules each, is 14 modules; which together make 22: and the two portions of metops,

enlargement of the middle intercolumn renders the entrance of the temple more ſpacious, and gives an appearance of dignity towards the ſtatue of the God.

Upon the capital of the triglyphs, the corona is to be placed, having, as before ſaid, a Doric cymatium at bottom and another at top. The thickneſs of the corona, with its cymatiums, is half a module. The under part of the corona, perpendicular to the triglyphs, and to the middle of the metops, is to be divided, for the direction of the viæ, and the diſtribution of the guttæ; all the reſt are the ſame as has been mentioned in the diaſtyle ſpecies.

Fig. XXVI. The columns are to be wrought in twenty ſtriæ[17*], which, if made flat, form twenty angles, (3, 5, 7;) but, if they are hollowed, they are to be thus performed. A ſquare (1, 2, 3, 4) is deſcribed, whoſe ſides are equal to the interval of a ſtria; in the center (8) of the ſquare, the central point of the compaſſes is placed, and a circular line drawn, touching the angles of the ſquare; and that portion of the curve (2 3), which is between the lines of the circle and the ſquare, forms the hollow of the ſtria. Thus the Doric column will have its proper kind of ſtriature. With regard to the ſwelling which it has in the middle, it is the ſame as has been deſcribed in the third book for Ionic columns.

As the ſymmetry of the external parts of Corinthian, Doric, and Ionic temples, has been deſcribed, it is alſo neceſſary to explain the internal diſtribution of the cell and pronaos.

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left at the angles, is another module, amounting in all to 23 modules.

The ſame computation alſo anſwers in the hexaſtyle temple; there are twelve triglyphs, which is 12 modules; eleven metops, which is 22 modules; and the portions of metops left at the angles is 1 module, which make in all 35 modules, the number of the text.

The objection is, that the metops will be half a module broader than it is ſuppoſed they ſhould be; notwithſtanding which, the exact agreement of the numbers in theſe two, as well as in the former two inſtances, with the ſpecies of intercolumniation mentioned, is a ſufficient argument to prove, that, ſuch a breadth in the metops was intended by Vitruvius in monotriglyph and ſyſtyle work, as he terms it, and eſpecially with columns, whoſe thickneſs is the ſeventh part of their heighth; for we find, by the examples before mentioned, that the ancients did not ſcrupulouſly adhere to the rule of making the heighth and breadth of the metops equal; or of giving them exactly a module and an half in breadth.

Alſo, in the ſecond chapter of the third book, Vitruvius ſays, *Columns whoſe thickneſs is the eighth part of their heighth, would appear groſs and unhandſome if uſed in pycnoſtyle work*; much worſe, therefore, would theſe (whoſe thickneſs is the ſeventh part of their heighth) appear in his opinion, if they were ſo applied: as even the ſmall draft, Fig. XVI, evinces. All which contribute to confirm the opinion, that he never intended ſuch application; and the perfect agreement and aptneſs of all theſe circumſtances, ſeem ſufficient to aſſure us of the juſtneſs of the reading as generally found in the text.

Fig. XVII. ſhews the Doric monotriglyph front with ſyſtyle intercolumns, as deſcribed by Vitruvius; and Fig. XVI. the ſame, with pycnoſtyle intercolumns, as altered by former editors.

(17*)In the Doric temple at Cora, before mentioned, is an example of both theſe ſorts of ſtriæ or channelling; the lower part of the columns having the flat, and the upper part the hollow kind of ſtriæ. See Fig. XXVI.

CHAPTER IV.

Of the internal Diſtribution of the Cell and Pronaos.[1*]

Fig. XVIII. THE temple is to be ſo contrived, that the breadth may be half the length, and the ſame cell be in length (K C) a fourth part more than the breadth,[2*] including the wall in which the doors are placed. The remaining three parts advance to the antæ (D) of the walls of the pronaos, which antæ ſhould be of the ſame thickneſs as the columns; and if the cell[3*] is more than XX feet in breadth, *Fig. XVIII.* two columns (1 2) are placed between the two antæ (D), which ſeparate the ſpace of the pteromatos[4*] and the pronaos. Alſo, the three intercolumns which are between the antæ (D) and columns (1 2), are cloſed with plutei[5*] of marble, or of inſide materials, leaving therein apertures to communicate with the pronaos.

(1*) It is proper to be mentioned, as a caution, that all the tranſlators before Galiani (who himſelf has made the remark) have ſuppoſed this chapter treated of a kind of temples different from thoſe before explained, and have made their draughts accordingly; whereas it is ſufficiently evident, by the reading of the context, that it treats of the internal parts of the ſame temples, of which the external only have been deſcribed.

(2*) I at firſt thought with Galiani, that the breadth here mentioned ſhould be underſtood to be that of the whole temple; but ſeveral concurring circumſtances obliged me to alter my opinion. Vitruvius ſpeaks of two columns (1 2, Fig. XVIII) to be placed between the antæ D, if the breadth exceeds twenty feet; and of two others (5 6) to be placed more inward, if the breadth exceeds forty feet. This neceſſarily ſuppoſes a conſiderable diſtance between the antæ D and the front walls C of the cell; but, if the length of the cell is a fourth part more than the breadth of the whole temple, no ſuch diſtance can happen, nor any ſuch columns be placed, as appears by Galiani's draughts, and as may eaſily be proved by trial on any of the draughts of temples. Fig. XVIII, XIX, and XX. But, if the breadth mentioned is underſtood to be that of the cell, then the parts happen ſuitable to this diſpoſition of columns, as is ſhewn by the plans of the peripteral temples above mentioned; which, therefore, is a ſufficient evidence that it ſhould be ſo underſtood.

This being the caſe, it follows, that the three parts mentioned to remain, and to extend to the antæ, muſt relate to the cell alſo; and, conſequently, that the word temple (*ædis*) at the beginning of the chapter, muſt be underſtood to ſignify the internal temple or cell only; that is, from the columns marked 1 2, to thoſe marked 3 4, excluding the periſtyle of columns around the ſame. The external proportion of the whole temple has been before deſcribed in the firſt chapter of the third book; and the uſe o this chapter is profeſſedly to explain the internal parts.

(3*) Here again the word *ædis* muſt be underſtood to mean the cell; becauſe the placing of columns, 1 2, Fig. XVIII, between the antæ D, muſt be ſuppoſed to depend on the diſtance of theſe antæ from each other, and on the breadth of the cell; alſo, becauſe, in peripteral temples (which are the temples in queſtion) a breadth of twenty feet in the whole would cauſe the cell to be too ſmall to require two columns to be placed in the breadth between the antæ thereof.

(4*) Pteromatos ſignifies the walks and ranges of columns on the flanks of the temple. See note 14, at the VIIth chapter of this book.

(5*) Plutei was the general name of all kinds of fences. To what heighth theſe plutei between the columns were raiſed we are not informed; but moſt probably they were only pedeſtal high. See note 3, chapter 1. book V.

Fig. XVIII. If the breadth is more than XL feet, columns (5 6) are placed more inward, oppoſite to the columns, between the antæ, and have the ſame heighth as thoſe in front; but their thickneſs is leſſened according to this rule; if thoſe in front are an eighth part of their heighth, theſe are made a ninth part; and if thoſe are a ninth or tenth, theſe are made proportional; for, on account of the incloſure of the air, this diminution will not be diſcerned; but if they ſhould appear thinner, the ſtriæ, being XXIV in the exterior columns, in theſe muſt be made XXVIII or XXXII, that what is taken from the ſubſtance of the ſhaft may be ſo retrieved by the additional number of ſtriæ as to be imperceptible: and thus columns of unequal thickneſs will be made to appear equal. The reaſon of this effect is, the eye ſeeing the objects more numerous and frequent, ſeems to paſs over a greater compaſs; for, if two columns of equal thickneſs are meaſured round with lines, one being ſtriated, the other not, and the line girts over the hollows and angles of the ſtriæ; notwithſtanding the columns may be of equal thickneſs, the lines which encompaſs them will not be equal, becauſe the girt of the ſtriæ renders one of the lines of a greater length. This being the caſe, it cannot be improper, in narrow and encloſed places, to make the ſymmetry of the columns more ſlender, provided we properly adjuſt the ſtriæ.

The thickneſs of the walls of the cell ſhould be in proportion to its magnitude, obſerving that the antæ are to be of equal thickneſs with the columns. If they are built with ſmall ſtones, they are to be regularly laid; but if ſquared ſtones or marble are uſed, they are generally formed rather ſmall and equal; becauſe the middle ſtones binding the middle joints, make the whole work ſtronger, and alſo the riſings, occaſioned by the preſſure about the joints and courſes, become more agreeable in appearance.

CHAPTER V.

Of the Poſition of Temples according to the Regions.

THE ſacred temples of the immortal Gods ſhould be ſo diſpoſed, that, if there is no impediment, and the uſe of the temple permits, the ſtatue which is placed in the cell may ſeem to look toward the evening region of the heavens; ſo that thoſe who approach the altar, to make their offerings, or perform ſacrifices, may look toward the eaſtern ſky, and to the image which is in the temple. By this means the temple, the eaſtern ſky, the ſupplicants and ſacrificers making their vows, and the image ſeeming to riſe to behold them, will all be ſeen at one view: for it is proper that the altars of the Gods ſhould be diſpoſed to the eaſt.

But if the nature of the place prevents that poſition, then the temple is to be turned to the view of the greater part of the city walls, and temples of the Gods; or ſhould ſacred fanes be built near a river, like thoſe near the Nile in Egypt, they ſhould look toward the banks of the river; ſo likewiſe, if near a public way, they ſhould be ſo ſituated, that the paſſengers may behold it, and pay their ſalutations.

CHAPTER VI.

Of the Proportions of the Portals[1*] of Temples.

THE rules relating to the portals of temples, and their antepagments[2*] (E), are theſe: firſt, it is to be determined of what kind they are to be made; for there are theſe kinds, Doric, Ionic, and Attic.

Fig. XXIX. and XXX. In thoſe of the Doric kind, theſe rules are to be obſerved: The top of the corona (A), which is placed above the upper antepagment, is made level with the top (o) of the capitals of the columns which are in the pronaos. The aperture or hypothyron is thus determined: The heighth from the pavement (B) of the temple to the lacunars[3*] (C), is divided into three parts and a half, of which two parts make the heighth of the aperture of the door.[4*] This (heighth) is divided into twelve parts, of which five and a

(1*) The Latin word *oſtia*, which ſignifies the aperture of the door, I have rendered portal, in order to preſerve the diſtinction between that and the framing of wood work, &c. made to cloſe or ſhut the ſaid aperture; and which is properly called the door.

(2*) The antepagments are the jambs of the door caſe, or perpendicular pieces of the architrave.

(3*) The lacunars have been before explained to be the cofers, or pannels. Thoſe in the cieling of the pronaos, which are thoſe here implied, were uſually on a level with thoſe in the ſoffite of the corona, as they are in the temple of Theſeus, at Athens; in that of the Sybil, at Tivoli; Veſta, at Rome, and divers others. They were placed ſometimes indeed at different levels, as at the top of the architrave, &c. But, as they were originally and moſt uſually at the level of the corona, and Vitruvius has ſpoken of no other than thoſe in the corona, we muſt ſuppoſe that he conſiders theſe which he here mentions to be on the ſame level.

(4*) This paſſage has, by all the tranſlators heretofore, been explained in a manner that no antique example has been found to authoriſe, and that has no reaſon of propriety or beauty to recommend it: they ſuppoſe that the corona of the cornice is intended by Vitruvius to be much more in heighth than all the reſt of the cornice, architrave and friſe together; as A, Fig. XXIX.

Vitruvius ſays that the top of the corona of the portal is to be made level with the top of the capitals of the columns in the pronanos; and at the ſame time directs the aperture of the door to be made of ſuch a heighth as cauſes the ar-

half make the breadth of the aperture at its bottom (B); and at the top it is contracted; if the heighth of the aperture is not more than ſixteen feet, as much as the third part of the antepagment. If the heighth is from ſixteen to twenty-five feet, the upper part of the aperture is contracted a fourth part of the antepagment. If from twenty-five to thirty, the upper part of the aperture is contracted an eighth part; and thoſe that are yet higher are to be diſpoſed perpendicular.

The antepagments (E) are made as thick in front as the twelfth part of the heighth of the aperture, and are diminiſhed at the top the fourteenth part of their thickneſs.[5*] The heighth of the ſupercilium[6*] (D) is equal to the thickneſs of the antepagment at the top. The

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chitrave, friſe, and under part of the cornice, to happen much lower; from whence it is ſuppoſed that he intends all the ſpace between to be occupied by the corona; which conſequently becomes of a monſtrous and diſproportionate heighth.

This is, as it muſt be univerſally allowed, ſo uſeleſs and unmeaning a deformity, and ſo contrary to all the known examples of the antique, that it encourages a ſuſpicion of its not being the intention of the author, and that it is a miſtake ariſing from ſome unaccountable error in the text.

I find two inſtances in the antique wherein the top of the corona of the portal is level with the tops of the capitals of the columns in the pronaos. Theſe are in the Doric temple at Cora, in Italy, and in the Sybils temple at Tivoli. But, in both theſe examples, the heighth of the aperture is two parts and an half, out of three and an half, from the pavement to the lacunars; whereas Vitruvius directs it to be no more than two parts.

If the heighth of the aperture is allowed two and an half, B B, Fig XXX, as in theſe examples; and all the other members are made in the proportions mentioned by Vitruvius; then, the top of the corona being made level with the top of the capitals, will cauſe the corona to be of a proper and moderate ſize, nearly equal with the abacus of the capitals; as figure XXX ſhews.

The agreement of theſe two examples in the ſame proportion, the ſuitableneſs of this proportion of the aperture to the diſtribution and proportion of all the other parts of the portal, the correſpondence of theſe ancient doors in all other reſpects to the deſcription of Vitruvius, joined with the incongruity and deformity that ariſes from the heighth of the aperture mentioned in the text, make it very probable that the error lies here, and that *duæ*, two, has been written inſtead of *duæ s.* or *duæ ſemis*, two and an half.

It is true that the generality of the ancient portals, which have come to our knowledge, are not ſo high in the aperture as thoſe of Cora and Tivoli: ſeveral of them agree with the text, and have but two parts, out of three and an half, from the pavement to the lacunars: ſuch are thoſe of the temples of Fortuna Virilis, Concord, and Veſta, at Rome (according to Palladio) and that of Pola, in Iſtria. But none of theſe are of the Doric or Attic kind; they are what Vitruvius calls the Ionic; whereas thoſe of Cora and Tivoli are both Attic; which, as Vitruvius hereafter ſays, is the ſame as the Doric, and which latter he is here deſcribing.

Thoſe ancient portals, that have the top of the corona level with the tops of the capitals of the columns, do not agree with the text in the proportional heighth of their aperture; and thoſe that agree in the heighth of their aperture have not the top of the corona level with the top of the capitals; nor can they have, unleſs ſome member of the entablature is made ſo unuſually large and diſproportionate as ſhocks the eye of the ſpectator. By theſe ancient examples, it appears that the Attic and Doric portals have, in their apertures, two and an half parts, out of three and an half, from the pavement to the lacunars; and the Ionic but two parts: and that the former have the top of the corona level with the top of the capitals, but the latter have not. I therefore conjecture, that Vitruvius has, in the deſcription, inadvertently united the proportion of the Ionic portal with that ſingularity of the Doric, of having its corona level with the top of the capitals, or elſe that he has written *duæ s.* for *duæ ſemis*; the *s*, according to cuſtom, ſtanding for *ſemis*, which the copyiſts have miſtakenly ſuppoſed; and that thus the error has ariſen. Whether or no this conjecture may be ſatisfactory and well founded, I ſubmit to the deciſion of the public. I cannot, however, be of opinion that Vitruvius could ever intend ſo exorbitant and diſproportionate a member as that large corona. Propriety, beauty, and the example of antiquity, conſpire to decry it. In practice, therefore, it appears to me moſt adviſeable to make the heighth of the aperture in Doric portals like thoſe of Cora and Tivoli: viz. $2\frac{1}{2}$ to $3\frac{1}{2}$; and, in Ionic portals, to give the aperture the heighth mentioned in the text: viz. 2 to 3.

(5*) Thus the portal of the Sybils temple at Tivoli, and that of Cora, are contracted.

(6*) In this place the ſupercilium ſignifies the level part of the architrave, D.

cymatium (F) is to be made the ſixth part of the antepagment, and its projecture is equal to its thickneſs. The Leſbian cymatium[7*] (F), with the aſtragal, is to be ſculptured. Upon the cymatium, which is in the ſupercilium, the hyperthyrum[8*] (G) is to be placed, in thickneſs equal to the ſupercilium, and therein is to be wrought the Doric cymatium, leſbiam, aſtragal, ſima, ſculpture[9*] (H). Then the plain corona (A), with its cymatium, is formed, and its projecture is equal to the heighth of the ſupercilium, which is laid upon the antepagments. To the right and left projectures[10*] (I) are made, as far as the footings extend[11*]; and in the ungue[12*] (K), the ſame cymatiums are united.

Fig. XXXI. But if the Ionic kind is to be uſed, the heighth of the aperture being found in the ſame manner as for the Doric, the breadth is determined, by dividing the heighth into two parts and an half, of which one part and an half makes the breadth of the aperture at bottom. The contracture is the ſame as in the Doric. The thickneſs of the front of the antepagments (E), is the fourteenth part of the heighth of the aperture; their cymatium is the ſixth part of their thickneſs. The remainder, excluſive of the cymatium, is divided into twelve parts; three of which make the firſt corſa[13*] (a), with its aſtragal; four the ſecond (b), and five the third (c). Theſe corſes, with their aſtragals, extend all round. The hyperthyrum is formed in the ſame manner as that of the Doric. The ancons (L L), or prothyrides[14*], (as they are called) are wrought on the right and left, and, excluſive of the

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(7*) The Leſbian cymatium I judge to be an ogee, or ſima reverſa; becauſe the generality of the ancient portals known to us, have this moulding for the cymatium of their antepagments; and thus it is in the portal of Cora, which in ſo many other reſpects agrees with the deſcription of Vitruvius.

(8*) The hyperthyrum is the friſe, or the friſe together with the bed-mould of the cornice.

(9*) This ſentence is very obſcure, *& in eo ſcalpendum eſt cymatium Doricum, aſtragalum Leſbium ſima ſcalptura.* Vitruvius does not tell us in what part of the hyperthyrum theſe mouldings are to be wrought, nor their proportion; and it is doubtful how or what we are to underſtand by *aſtragalum Leſbium ſima ſcalptura.*

In the portal of the temple at Cora, the mouldings at the top of the hyperthyrum, ſerving as the bed-mould to the cornice, are a cavetto with its fillet; above that, dentils; and upon them, an aſtragal enriched with beads, having a fillet above and below it. Their proportion all together is two ſevenths of the heighth of the hyperthyrum. Vitruvius mentions no dentils, but a ſima; and places the aſtragal between that and the Doric cymatium.

(10*) The projectures here ſignified are doubtleſs thoſe which we call knees, made by the excurſion of the cymatium at the upper part of the antepagments; for we find ſuch projectures were frequently uſed in the works of the ancients, as in the windows of an ancient Ionic temple now remaining at Athens. In thoſe of the Sybil at Tivoli, and in the portal of the temple at Cora. In this laſt, the quantity of their projecture is equal to a fourth part of the breadth of the antepagment; and their extent from the top of the ſupercilium downward, is equal to the heighth of the whole ſupercilium, added to the heighth of its cymatium and faſcia; ſo that the knee of the facia ranges exactly with the bottom line of the ſupercilium.

(11*) Galiani ſeems to have rightly conceived this paſſage; the footing, or crepido, here mentioned is probably the cill, or ſtone, that bears the antepagments. Vitruvius, therefore, would have the knees project ſo far as to be perpendicular with the outſide of the antepagments at bottom.

(12*) Ungue, I imagine, expreſſes no more than the ſeveral turns or bends of the knee.

The great projection given to the corona ſeems to make it neceſſary to have truſſes (or ancons, as they are hereafter called); ſuch truſſes there are adjoining to the knees in the portal of the temple at Cora, as L L, Fig. XXX.

(13*) *The faſcia.*

(14*) The truſſes or conſoles: thoſe of the temple at Niſmes are, according to Palladio, formed narrower at bottom than at top, as here directed.

leaf, deſcend as low as the bottom of the ſupercilium. The thickneſs of theſe in front is the third part of the thickneſs of the antepagment; and, at bottom, they are a fourth part thinner than at top.

THE doors are ſo framed, that the cardinal ſcapi[15*] (d), may be the twelfth part of the whole heighth of the aperture. Out of twelve parts between the two ſcapi, the tympans[16*] (e) have three parts. The impages[17*] (f) are ſo diſtributed, that the heighth being divided into five parts, two ſuperior, and three inferior, are diſpoſed. Upon the middle the middle impages are placed; of the reſt, ſome are framed at top, and ſome at bottom; the breadth of the impage is the third part of the tympan; the cymatium (g) is the ſixth part of the impage; the breadth of the ſcapi (h) is the half of the impage; the replum[18*] (i) is

(15*) Scapi are all the pieces in general, which are diſpoſed perpendicularly, and which we call ſtiles: the cardinal ſcapi I ſuppoſe to be the hinge ſtiles, or rather the door-poſts to which the doors are hinged. The ſcapi are mentioned twice afterward; the firſt mentioned of the two, I take to be the middle ſtiles of the door; and the other, the ſide ſtiles, (*i. e.*) thoſe next the antepagments. It is not determined whether each of the cardinal ſtiles is to have in breadth the twelfth part of the heighth of the aperture, or whether that meaſure is to be divided between both. I have choſen the latter: Galiani has altered *altitudinis*, in the text, to *latitudinis*, thereby making theſe cardinal ſcapi to be the twelfth part of the breath inſtead of the heighth.

(16*) The tympans are the pannels. Perault and Barbaro make but one pannel in the whole breadth of the aperture; but the manner in which the ſcapi are three times mentioned, proves, that there muſt be at leaſt four ſcapi excluſive of the cardinal ſcapi; and, conſequently, two pannels in the breadth: and this induces me to think that the twelve parts, out of which the tympan has three, are to be underſtood to be in the breadth of the aperture, between the two cardinal ſcapi, not in the heighth of the aperture, of which the cardinal ſcapi has before had one twelfth; for, thus underſtanding it, the meaſures allowed to the tympans, ſcapi, &c. are reconcileable with that of the breadth of the aperture, otherwiſe not.

(17*) The impages are ſuppoſed to be the horizontal pieces of the framing, called by us the rails. The tranſlators in general, excepting Galiani, have made but three in the whole heighth; one in the middle, and the other two at top and bottom of the door; but it is evident, by the expreſſion of the text, *ex reliquis alii in ſummo alii in imo, of the reſt, ſome above and ſome below*, and afterward mentioning one in the middle, that there muſt be at leaſt two impages, if not more, both above and below the middle one.

(18*) The replum has been variouſly interpreted; but the moſt general received opinion is, that it is the riſing part of the pannel, by us called the raiſing.

The twelve parts of the breadth are thus accounted for:

The two tympams, at 3 each,	6
The four ſcapi, at $\frac{1}{2}$ each,	2
The four replums, at $\frac{1}{2}$ and $\frac{1}{6}$ each,	$2\frac{2}{3}$
The four cymatiums, at $\frac{1}{6}$ each	$0\frac{2}{3}$
The middle aſtragals, or ſtaffs, n n,	$0\frac{2}{3}$
In all	12

After all, I am far from being ſatisfied that the deſign given by the other tranſlators, or myſelf, (though moſt correſpondent to the text I could imagine) is to be depended on as the true formation of the ancient doors. I rather believe (founding my opinion on the circumſtances of the deſcription) that they were framed in a manner of which we have at preſent no idea.

We imagine the ſcapi are the perpendicular, and the impages the horizontal margins of the door; why then ſhould the former be but half the breadth of the latter? We know not whether the cymatium is included, in the meaſure allowed to the impage, or excluded; whether it is at top of the impages only, or at bottom alſo; whether it projects or recedes, and whether it is to be applied to the ſcapi as well as to the impages; whether the middle impage is to be placed at the true middle of the heighth of the aperture, or that point which ſeparates two parts above from three below. We are not informed how many impages there are to be made above and below the middle one, nor how they are to be diſpoſed; and we know not what is certainly meant by the replum; wherefore the deſcription conveys to us no clear idea, but is obſcure and unintelligible; and the generality of the tranſlators have therefore contented themſelves with giving a draught of the doors according to their own fancy, without regard to its conformity to the words of the text.

the half and a ſixth part of the impage; the ſcapi (k), which are neareſt the antepagments, are alſo the half of the impage.

BUT if they are valved[19*], the heighth remaining the ſame, the width of the door is augmented[20*]. If they are quadrifors, the heighth alſo is encreaſed.

Fig. XXX. THE Attic kind are formed according to the ſame rules as the Doric, but have alſo corſes[21*] (n), under the cymatiums in the antepagments, worked all round; and ſo proportioned as to have two parts out of ſeven contained in the antepagment, excluſive of the cymatium; and theſe doors are not made with ceroſtrota[22*] ornaments, nor bifors, but valved; and they have apertures in the exterior parts[23*].

THESE rules, which are practiſed in the compoſition of Doric, Ionic, and Corinthian temples, I have explained as well as I have been able, according to the approved methods. I ſhall now ſpeak of the compoſition of Tuſcan temples, and of the manner in which they ſhould be conſtructed.

(19*) This expreſſion implies, that the door juſt deſcribed is not of the valved kind, but it does not inform us what valved doors are. Galiani ſuppoſes them to be one-leaf doors; Perault, two-leaf doors, in this place; and in the following paſſage, one-leaf doors. It is certain they are neither two-leaf doors, called bifors, nor four-leaf doors, called quadrifors; becauſe Vitruvius here oppoſes them to both; and it is not probable that they are one-leaf doors; becauſe Vitruvius, after having allowed an ample width for the door deſcribed, ſays, if they are to be valved they muſt be wider; which implies that they are not one-leaf doors; for it is not to be ſuppoſed that doors that have but one leaf ſhould be directed to be made wider than thoſe that have two or more leaves; it is rather a reaſon for making them narrower. Indeed, we are not told the number of leaves in this deſcribed door; but thoſe that ſuppoſe the valved to be one-leaf doors, muſt ſuppoſe this to have two or more leaves; for it is evidently not a valved door, as before noted, and conſequently they muſt ſuppoſe the one-leaf door is directed to be made wider than a door of two or more leaves; which is abſurd and improbable.

The door deſcribed is probably a bifors, or two-leaved door, as Galiani conceives it; the diſtribution and proportion of the parts agree with ſuch a formation; if ſo, and if it ſeems likely that, as the valved doors are directed to be made wider, they have conſequently more leaves than the door deſcribed, and yet are not quadrifors; it is moſt probable that they are three-leaved doors, having the middle leaf hinged to one of the ſide leaves; and this opinion is, in ſome degree, confirmed by the order in which they are mentioned by Vitruvius; for he proceeds from the door deſcribed, which is probably a bifors, to the valved, and then to quadrifors.

(20*) The words of the text, *in latitudinem adjiciatur amplius foris latitudo*, ſeems to encourage a notion that the breadth of the aperture is to be encreaſed by as much as the breadth of one door, meaning, I ſuppoſe, one leaf, as Galiani has underſtood it; but I do not venture to render it in that ſenſe, becauſe the words will equally well bear the conſtruction I have choſen; and utility, as well as the authority of the antique, oppoſes ſuch a proportion, which makes the door almoſt as broad as high. We find none of the doors of the ancient temples much wider than half their heighth, though there are ſeveral that are higher than twice their width.

(21*) The corſes of the Sybil temple at Tivoli, and thoſe of the temple at Cora, are formed according to this rule.

(22*) Ceroſtrota is mentioned by Pliny as a kind of inlaid work.

(23*) Some have rendered this paſſage, the doors open outward; others render it as I have done. The text is, *& aperturas habent in exteriores partes:* the ſenſe depends on the acceptation of the word *aperturas*, whether it ſignifies apertures; or, the action of opening.

CHAPTER VII.

Of the Proportions of Tuſcan Temples.

Fig. XXXII. THE length of the place (m m), on which the temple is erected, being divided into ſix parts, one is deducted, and the remainder given to the breadth (k k). The length is divided in two parts; the interior part (m n) is aſſigned for the ſpace of the cell, and that next the front is left for the diſpoſition of the columns. The breadth is divided into ten parts; of which, three to the right and left are given for the leſſer cells (a), or for the places of the wings (b); the remaining four are allotted to the middle temple (h). In the ſpace of the pronaos (B), which is before the cells, the columns are ſo diſpoſed, that thoſe of the angles (d) may ſtand oppoſite to the antæ (c), at the extreme parts of the walls. The middle two (e), oppoſite the part of the walls which is between the antæ and the middle temple, are ſo ſituated, that, between the antæ (c), and the prior columns (d), in the middle of the ſame line, others (g) may be diſpoſed.

Fig. XXVII. THE thickneſs of theſe columns at bottom is the ſeventh part of their heighth; their heighth is the third part of the breadth of the temple; and the tops of the columns are diminiſhed a fourth part of the thickneſs of the bottom. Their baſes (r a) are in heighth the half of their thickneſs, and have a circular plinth (r) as thick as half their heighth.

THE torus above, with the apophygis (a), is as thick as the plinth. The heighth of the capital (k h) is half the thickneſs of the column. The breadth of the abacus (k) is equal to the thickneſs of the column at bottom. The thickneſs of the capital is divided into three parts; one of which is given to the plinth (k), that ſerves for the abacus; another to the echinus (i), and the third to the hypotrachelian (h), with the apophygis[1*] (b).

(1*) Apophygis is the fillet, or ſquare, that terminates the ſhaft of the column at the top and bottom. In the 1ſt chapter of this book, it is called apotheſis. Philander and Barbaro have added *aſtragalo* to the text, where only *apophygis* is mentioned; in which they are followed by Perault and Galiani, they believing that the apophygis there mentioned is the fillet, c. Fig. XXVII, at the bottom of the hypotrachelion, or rather at the top of the column. Nevertheleſs, I am of the opinion of Palladio, that it here means the fillet, b, under the echinus; and I judge that Vitruvius has purpoſely avoided mentioning the aſtragal and fillet, d, at the top of the column, as being no part of the capital: for in deſcribing the Doric capital at the third chapter of this book, he alſo omits mentioning the ſame aſtragal and fillet.

At the firſt chapter of this book, where he deſcribes the Corinthian capital, he ſpeaks of ſuch an aſtragal as being at the top of the ſhaft of the column, but does not deſcribe its proportion; we may therefore conclude, that though he allows of its uſe, he conſiders it as a part of the ſhaft, and no ways belonging to the capital; for which reaſon he makes no

UPON the columns the compacted beams (e) are laid, being in heighth as much as the magnitude of the work may require, and in thickneſs equal to the hypotrachelium at the top of the columns. They are to be joined in ſuch a manner with mortiſe and tenon, as to leave a vacancy of two digits (1 inch and $\frac{1}{2}$) in the joints; for, if they touch, and admit not the air between them, they ferment, and quickly decay. Over the beams, and over the walls, the mutules (f) are projected the fourth part of the heighth of the columns, and antepagments[4*] are fixed in their fronts. Upon theſe the tympan of the faſtigium is built, either of maſonry or timber; and thereon, the faſtigium, columen, canthers, and templats[5*], are ſo diſpoſed, that the gutters of the whole roof may correſpond in a triple number[6*].

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mention of it in deſcribing the capital; for theſe reaſons, I believe the apophygis here mentioned cannot be that below the capital, but that under the echinus within the capital.

We find the aſtragal and fillet, or apophygis, d, at the top of the ſhaft of columns, generally uſed in the Roman works, though not always in thoſe of the Greeks; as, therefore, their uſe is authorized, and Vitruvius has omitted to give us their proportion, I ſhall copy them from the Theatre of Marcellus, in which the proportion of the aſtragal and fillet together is the fifteenth part of the diameter of the column.

(2*) Theſe walls I conceive to be the lateral and back walls of the temple; which, therefore, ſhould be built up to the level of the top of the beams, which lie over the columns, in order that the mutules may be upon a level all round the temple. Several of the tranſlators have underſtood them to be walls built upon the beams, by way of friſe; without any reaſon for ſuch opinion, more than what is here mentioned. But, if that had been the caſe, I think Vitruvius would not have failed to particularize their ſituation and heighth, becauſe they materially affect the aſpect and proportion of the temple.

(3*) None of the tranſlators have been able to prevail on themſelves to believe that the mutules are intended to project ſo far as is equal to a quarter of the heighth of the columns. Wherefore Galiani has ſuppoſed it ſhould be read a quarter of the thickneſs of the columns, and accordingly has altered the text from *altitudinis* to *latitudinis*. But, if they had ſeen our church in Covent-Garden, the work of the famous Inigo Jones, they would not have been ſo dubious of the meaning of the text. In the ordination of this church, it ſeems as if Inigo Jones had intended to put in practice the rules given by Vitruvius for the conſtruction of Tuſcan temples.

(4*) What is here meant by the word antepagments is uncertain; Galiani thinks it means ornaments in a general ſenſe; it may ſignify ſome moulding affixed to the fronts of the mutules, like thoſe of the antepagments or architrave of doors, as g, Fig. XXVII; or, as I obſerve, no mention is made of any corona, &c. to cover the mutules (which, nevertheleſs, is abſolutely neceſſary and indiſpenſable;) it may be ſome mouldings lying above the mutules, and appearing like a cornice, as Piraneſi, has repreſented it in his Magnificenza di Roma.

(5*) Theſe timbers have been before explained at the ſecond chapter of this book.

(6*) This paſſage is very obſcure and variouſly underſtood; *ut ſtilicidium tecti abſoluti & tertiario reſpondeat.*

The interpretation that occurs to me is, that the waterſpouts, which are to diſcharge the rain from the roof of the temple, are to be three in either flank anſwering each other, as i, k, l, fig. XXXII, and which fall very aptly over the columns, antæ, and middle, of the cell, at equal diſtances; as in other temples, they have been deſcribed to be in the lions heads over each column in the flanks. Galiani ſuppoſes theſe words import, that dripping eaves (as our workmen call them) are to be formed on three ſides of the temple, the back part of the roof being ſloped like the flanks; and Perault, and others, have ſuppoſed the word tertiaro (following the ſignification of that word as given in Baldus's dictionary) to mean the pediment or hips of the roof; tranſlating the paſſage to this effect, *the ſlope of the roof is to agree with the pediment*; and Perault has added, without any authority, *which ought to be much elevated.* By this interpretation, they entirely neglect the word *ſtilicidium* (i. e. the gutters or channels;) which appears to me to be the principal in the ſentence; for it is the gutters which Vitruvius ſays ſhould correſpond in *tertiario*; a word relative to the number three; the paſſage, therefore, plainly ſignifies that the gutters are in ſome manner to correſpond in that relation.

Fig. XXXIII. They alſo erect round temples, of which ſome, built with columns, without a cell, are called monopteral,[7*] and others peripteral. Thoſe which are made without a cell, have a tribunal and an aſcent[8*] (a), equal to a third part of their diameter. Upon the ſtylobata (a), the columns are raiſed, equal in heighth to the extreme diameter of the walls of the ſtylobata; their thickneſs is the tenth part of their heighth, including the capitals and baſes. The epiſtylium is in heighth equal to half the thickneſs of the columns. The zophorus, and the other members which are placed above, conform to the rules written in the third book.

Fig. XXXIIII. But if theſe temples are to be made peripteral, two ſteps (b), and the ſtylobata (a), are built at the bottom; then the wall (c) of the cell is made receding from the ſtylobata, about the fifth part of the breadth[9*]; and at the middle of the approach is left the place of the doors (d). The cell (e), excluſive of the walls, is equal in diameter to the heighth of the columns above the ſtylobata. The columns around the cell are formed according to the ſame proportions and ſymmetry as has before been mentioned. The proportion of the roof in the middle is ſuch, that half the diameter of the whole work makes the heighth of the tholus[10*] (g), excluſive of the flower. The flower[11*], without the pyramid,

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(7*) Monopteral ſignifies having but one wing or aile.

(8*) The tribunal and aſcent, here mentioned, is evidently the pedeſtal, or podium, upon which the columns ſtand; for immediately after it is called ſtylobata. There was, no doubt, a flight of ſteps in the front to aſcend this podium, though Vitruvius gives us no information concerning them; but Piraneſi, in his Magnificenza di Roma, gives us a repreſentation of a temple of this kind, which he diſcovered on an ancient fragment, in the Villa Medici at Rome, where the ſteps appear to be raiſed between the two front columns; alſo Palladio and Serlio, who drew the Sybils temple at Tivoli many years paſt, have placed the ſteps in the front intercolumn; and the preſent ruins of that temple evince that they could have been in no other place, or have extended farther; the podium mouldings ſtill remaining under the column adjoining to the front intercolumn: I have accordingly repreſented the ſteps in that manner, in my draughts, Fig. XXXIII and XXXIV. The text very clearly expreſſes that the heighth of this tribunal, or podium, is to be equal to the third part of its diameter, as it is found in the examples above-mentioned; yet, (for what reaſon I know not) none of the tranſlators have conformed thereto in their draughts.

(9*) Vitruvius ſays about the fifth part. In the Sybils temple at Tivoli, and in the temple of Veſta at Rome (both of them round temples of this kind) the receſs of the wall of the cell, from the front of the ſtylobatæ, is equal to a third part of the heighth of the columns; ſo that when the diameter of the cell, including the walls, is made equal to the heighth of the columns, as it is in the Temple of Veſta, the ſaid receſs is exactly a fifth part of the whole diameter.

(10*) The tholus is the cupola, or dome; it ſometimes ſignifies the center ſtone or ornament in the crown of the dome. Concerning the figure of the dome of the cell, which appeared above the entablature of the columns, we can draw no information from the antique, that part of the temple at Tivoli being deſtroyed; but there is a part of the wall of the cell ſtill left, which riſes above the level of the cornice, and which ſhews no inclination from the perpendicular like the arch of a dome; ſo that the ſpringing of the dome muſt have been above that part, if any dome there was; for in the relievo of the monopteral round temple, in the villa Medici, there is no dome, but a blocking, or plinth, upon the cornice; and above that, a roof, like that of the Tower of the Winds at Athens; the ſtones that formed the roof being, in the ſame manner, cut into the figure of tiles.

(11*) We know not the figure of the flower here mentioned; but, as it is ſaid to be of the ſize of the capitals of the columns, it may alſo have been of a ſimilar ſhape; for thus it was found to have been in the Temple of the Winds at Athens, according to Mr. Stuart.

The temple of the Sybil at Tivoli, agrees very aptly, in ſo much as remains of it, with the deſcription here given; that of Veſta at Rome is alſo very ſimilar; but, in this latter, the diameter of the cell, including the walls, is equal to the heighth of the columns; whereas in the former the cell is of that diameter, excluſive of the walls; therein conforming to the rule here given; Vitruvius has mentioned the thickneſs of the wall of the cell, in the temple at Tivoli above-mentioned, it is of the ſame thickneſs as the columns around it.

is equal in ſize to the capital at the top of the columns. All the other parts are to be made according to the proportions and ſymmetry already deſcribed.

With the ſame ſymmetry, temples of other kinds, and of different diſpoſitions, are produced; ſuch as, the temple of Caſtor, in the Circus Flaminius; and that of Vejovis, between the two groves; or as the more ingenious temple of Diana of the Woods, having additional columns to the right and left, on the flanks of the pronaos. The temples that were firſt built of the kind like that of Caſtor in the Circus, was the temple of Minerva in the citadel[12*] of Athens, and of Pallas, at the promontory of Sunium in Attica; for the proportions of theſe are not different, but the ſame; the length of the cells being double the breadth; and the other exiſona[13*], which are uſually in the fronts, are transferred to the ſides.

Some alſo taking the diſpoſition of the columns of the Tuſcan kind, uſe them with the ordination of Corinthian and Ionic works; for, by erecting two columns, in the places where the antæ procur into the pronaos from the walls of the cell, they render the Tuſcan and Grecian works of common principles.

Fig. XVI. and XVII. Others, removing the walls of the cell to the intercolumns of the pteromatos[14*], by that removal of the walls, render the chamber of the cell more ſpacious; and by preſerving the ſame proportions and ſymmetry in the other parts, produce another kind of temples, named *pſeudoperipteros*[15*]. Temples of this kind are apropriated to the uſe of ſacrifices: for the ſame kinds of temples are not erected indiſcriminately to all the Gods, becauſe the ſacred rites performed to each are different.

(12*) Here, as well as at the firſt chapter of the ſecond book, the word *arce* has evidently the ſignification of citadel; at the twelfth chapter of the fifth book, it ſignifies *dams* or *fences*.

(13*) We are ignorant of the meaning of the word *exiſona*, it not being uſed by any other author. In the draught of this temple of Minerva, given by Le Roi, in his Ruins of Greece, we find nothing ſingular in the flanks that is tranſferred from the front. The columns, entablature, &c. on the flanks, have the ſame form and proportion as thoſe in the front; the word *(exiſona)* therefore, may ſignify nothing more than the proportions, and ordination of the building in general; for Vitruvius, having juſt mentioned the proportions of the cell, immediately after adds, *& uti reliqua exiſona, the other exiſona.*

This temple, according to Le Roi, has eight columns in front and ſeventeen in the flanks, including thoſe at the angles; and there is another range of ſix columns, behind the front columns, forming a kind of double portico; the poſticus is alſo built in the ſame manner; but the proportion of the cell is not as Vitruvius has deſcribed it, being much longer than double its breadth. There is, however, an ancient temple at Pœſtum of this kind, whoſe cell is in length twice its breadth exactly. *See Major's Ruins of Pæſtum.*

(14*) This paſſage evidently proves that the word *pteromatos* does not ſignify the whole circuit of the periſtyle round the cell, as Galiani ſuppoſes: for in the ancient pſeudodipteral temples ſtill remaining (which are thoſe of Concord, Fortuna Virilis, and that of Niſmes in France) we find the ſpace of the pronaos left open, and not engroſſed by the cell, as the ſpace of the walks in the flanks and poſticus were; it therefore can only ſignify the walks on thoſe three ſides; but it more probably only means the walks in the flanks, becauſe that in the back front was particularly diſtinguiſhed by the name of poſticus. As, therefore, pronaos and poſticus were the common names of the walks in the front and rear, ſo pteromatos was probably the name of thoſe in the flanks.

(15*) Pſeudoperipteros (*i. e.*) falſe winged round.

THUS I have explained the rules of all kinds of temples as they have been imparted to me, and have diſtinguiſhed their order, the ſymmetry of their parts, wherein they are different in figure, and in what each reſpectively differs, as well as I have been able. I ſhall now ſpeak of the altars of the immortal Gods, and of their proper diſpoſition for the rites of the ſacrifices.

CHAPTER VIII.

Of the Altars of the Gods.

ALTARS ſhould regard the eaſt,[1*] and be always placed lower than the ſtatue which is in the temple, that the ſupplicants and ſacrificers may look upward to the divinity, and ſtand, as decorum requires, at a different heighth to the God. The heighths of altars are ſo adjuſted, that thoſe of Jupiter, and all the celeſtial Gods, may be diſpoſed as high as convenience will admit. Thoſe of Veſta, and the Gods of the earth and ſea, are ſituated lower. By theſe inſtructions the diſpoſition of the altars in the middle temples[2*] may be properly contrived.

IN this book is explained the compoſition of temples. In the following we ſhall give the rules for the diſtribution of public buildings.

(1*) Vitruvius has told us, at the fifth chapter foregoing, that altars ſhould face the eaſt, and that the ſtatue ſhould face the weſt, ſo that the altar and ſtatue faced different ways; yet, he there ſays, the ſacrificers look toward the ſtatue and to the eaſt, and that the ſtatue faces them; this is irreconcileable and contradictory; ſo that, I imagine, we muſt underſtand, by the words *aræ ſpectent ad orientem*, that the altars ſhould be ſituated at the eaſt end of temples, and conſequently face the weſt.

(2*) I have tranſlated *in mediis ædibus*, *in the middle temples*, as I think the words import; meaning thereby the cell of the temple, not the middle of the temple, as Galiani reads it; for it is more probable that the altars were placed toward the end oppoſite to the entrance; by that means leaving more room for the ſacrifices, cauſing the whole aſſembly to ſtand before the image of the God, not partly behind it, and giving to the whole an appearance of more dignity. Alſo, the note foregoing helps to determine the point, for by that it appears probable that they were placed on the eaſt ſide.

THE END OF THE FOURTH BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE FIFTH.

PROEM.

MANY authors, O Emperor! who, in voluminous works, have written of ingenious arts and inventions, have given great and ſingular reputation to their ſubject; would alſo that our art might be here ſo explained, that its reputation might, by theſe precepts, be augmented! But all that may be deſired is not eaſily obtained; for architecture cannot be treated like hiſtory or poetry. Hiſtory, of itſelf, engages the attention of the reader by the variety and novelty of the relations. Poetry alſo, by the meaſure and cadence of the verſes, the agreeable diſpoſition of the words and ſentences, and the juſt pronunciation of the lines, allures the ſenſes of the reader, and entices him, without ſeeming tedious, to the concluſion of the poem. But this cannot be done in writing of architecture; becauſe the peculiar terms of the art being unuſual, render the ſenſe of the diſcourſe obſcure. The terms therefore being of themſelves abſtruſe, and withall being uncuſtomary, if the various precepts are not contracted, and briefly and clearly explained, the diſcourſe will be often unintelligible, and the reader uncertain of its meaning.

In ſpeaking therefore of the unknown names and meaſures of the members of buildings, I briefly expreſs them, that the mind may conceive and the memory retain them more eaſily; conſidering alſo, that the attention of the citizens is ſufficiently engaged by the public affairs

of the city, as well as their own private concerns, I judge it proper to write briefly, that, in their ſmall intervals of leiſure, they may ſoon read and underſtand the ſubject. Pythagoras, and thoſe who followed his opinions, choſe to write the precepts of their doctrine in a cubical diſpoſition, the cube being conſtituted of CCXVI* verſes, of which, they maintain, each precept ſhould occupy no more than three.

The cube is a figure of VI ſquare equal ſides, ſo that being thrown, on which ſide ſoever it falls, it remains ſtedfaſt and immoveable, till it is removed by force; ſuch are the dice which the gameſters throw on hollow tablets. Hence the compariſon ſeems to be received; for this number of verſes, like the cube, fixes ſtedfaſtly in the memory that which ſoever meets the ſenſes. The Greek dramatic poets alſo divide the action of the fable in ſuch a manner, that the parts have a cubical relation to each other, interpoſing the ſongs of the chorus, to give reſpite to the pronunciation of the actors. As therefore our anceſtors have uſed ſuch methods, and as the ſubject on which I write is to many unknown and obſcure, I think it moſt proper to deſcribe it in ſhort books, that it may be more eaſy to the underſtanding of the reader. The ſubjects are likewiſe ſo arranged, that thoſe of the ſame kind are explained in one place, and not ſeparately diſpoſed; for thus they will more readily be comprehended.

In the third and fourth books I have explained, O Cæſar! the proportions of temples; in this, I ſhall treat of the proper diſpoſition of the public buildings; and firſt of the forum, becauſe therein the magiſtrates regulate both public and private affairs.

(*) The cube of 6. See note 6, chap. I. book III.

CHAPTER I.

Of the Forum.

THE Greeks make their forums ſquare, with large double porticos, the columns cloſe together, and adorned with ſtone or marble epiſtyliums, making ambulatories in the upper ſtories: but the cities of Italy follow not the ſame method; becauſe, by ancient cuſtom, the ſhews of gladiators are uſually given in the forum. For this reaſon the intercolumns around the area are made wider; and in the ſurrounding porticos the ſhops (a) of the bankers are diſpoſed, with galleries in the upper floors, properly adapted for the uſe and management of the public revenue. *Fig. XXXV.*

THE magnitude of the forum (A) ſhould be ſuitable to the number of the people, that it may not be too ſmall for uſe, nor, on account of the ſcarcity of people, appear too large. The proportion is ſo determined, that the length being divided into three parts, two are given to the breadth: for thus it will be of an oblong form, and convenient for the uſe of the ſhews.

THE upper columns are made a fourth part leſs than the lower; becauſe, as the inferior ſuſtains the greater weight, it ſhould be ſtronger than the ſuperior: alſo, becauſe it is proper to imitate nature; for, in ſtraight growing trees, ſuch as the fir, cypreſs, and pine, there are none thicker at the top than at the root; and, as they grow in heighth, they gradually diminiſh to the uppermoſt point. Following therefore the example of nature, it is proper that the ſuperior ſhould be made leſs than the inferior, both in heighth and thickneſs.

THE baſilica (B) ſhould be adjoined to the forum on the warmeſt ſide, that the negotiants may confer together, without being incommoded by the weather. The breadth is not made leſs than the third, nor more than the half of the length, unleſs the nature of the place oppoſes the proportion, and obliges the ſymmetry to be different. But if 1*

(1*) Galiani remarks that this proportion alludes to the middle diviſion, or nave, excluſive of the portico on either ſide; becauſe the Baſilica, Vitruvius afterwards deſcribes of his own deſigning, does not otherwiſe conform to his own rule.

On the contrary, I am of opinion that the whole extent of the baſilica is here meant, and that the baſilica deſigned by Vitruvius was an exception to the general rule; for, after having deſcribed the common baſilicas, he ſays, *Neither will baſilicas, like that at Fanum, which I deſigned and conducted, have leſs dignity and beauty:* which words clearly indicate it to be of a different form and proportion from thoſe he had been deſcribing. The draught I have given is of that at Fanum, which is hereafter deſcribed; the ſimplicity of the others render them eaſily conceivable by the verbal deſcription.

the basilica has too much length, chalcidicæ[2*] are made at the ends, as they are in the basilica of Julia Aquiliana. The columns of the basilica are made as high as the porticus is broad. The porticus is the third part of the space in the middle. The upper columns are less than the lower, as above written. The pluteum[3*], which is between the upper columns, should also be made a fourth part less than the same columns, that those who walk in the floor above may not be seen by the negotiators below. The epistylium, zophorus, and coronæ, are proportioned to the columns, in the manner explained in the third book.

Fig. XXXV. Nor will basilicas of the kind of that at the colony of Julia of Fan[illegible], which I designed and conducted, have less dignity and beauty; the proportions and symmetry of which are as follows: The middle testudo[4*] between the columns is CXX feet long, and LX feet broad. The porticus (b) around the testudo, between the walls and columns (c) is XX feet broad. The heighth of the continued columns (c), including their capitals, is L feet, and the thickness five, having behind them parastatæ (d) XX feet high, two feet and a half broad, and one foot and a half thick, which sustain the beams that bear the floors of the porticos. Above these are other parastatæ (e) XVIII feet high, two feet broad, and a foot thick, which also receive beams sustaining the canthers of the porticos, which are laid below the roof of the testudo: the remaining space (f) that is left between the beams which lay over the paristatæ, and those which lay over the columns, is left open in the intercolumns, in order to give light. The columns in the breadth of the testudo, including those of the angles to the right and left, are four; and in the length, on that side which is next the forum, including the same angle columns, eight. On the other side, there are but six columns, including those of the angles, because the middle two on this side are omitted, that they may not obstruct the view of the pronaos (C) of the temple of Augustus, which is situated in the middle of the side wall of the basilica, looking toward the center of the

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(2*) Various are the conjectures concerning the chalcidicæ and their use, but none can be depended on, because there are no datæ from which any inferences may be drawn; from what is here said of them, we can draw no farther knowledge than that they were some kind of apartments separated by a partition at the ends of the basilica.

(3*) In the seventh chapter of this book, it evidently appears that the pluteum is some part between the cornice of a lower order and the columns of an order immediately above, and its heighth is the two ninths of the heighth of the incumbent columns: also, in the said chapter, the continued pedestal at the bottom of the scene, called pulpitum, is afterward referred to by the name of podium and lower pluteum. These circumstances demonstrate that the pluteum is a kind of podium. This podium is here described to be between, not under, the columns, and it is to be a fourth part less than the said columns. Whether less in heighth or in thickness is not mentioned; but most probably the former is meant, considering the purpose it is to answer. In this case, its heighth is nearly equal to that of the columns, which heighth greatly exceeds the proportion usually given to a podium; but as Vitruvius, in his description of the parts of the orders, makes no mention of the proportion of the stylobatæ or podium, it may be supposed the proportions of these things were unlimited, and depended wholly on the option of the designer, or their particular use. This is confirmed by the examples of the antique, in which they are found of all proportions, from a third to a sixth part of the heighth of the incumbent column. In this latter proportion they are seen, in the remains of the Poikile at Athens. And in the scene described by Vitruvius, at the seventh chapter of this book, the lowest podium, or pulpitum, is a third part of the heighth of the incumbent column: the middle podium is two ninths, and the upper one a seventh part of the said heighth.

(4*) By the middle testudo is to be understood the middle part, or nave, which, from this expression may be supposed, to be vaulted above, in a flat arch, like the back of the testudo or tortoise; for the Romans distinguished such kind of arches by that name.

forum (A) and temple of Jupiter (H.) The tribunal[5*] (g) in this building is formed in the figure of a hemicycle[6*]: the extent of this hemicycle in front is XLVI feet, and the receſs of the curvature inward XV feet, ſo that thoſe who attend the magiſtrate obſtruct not the negotiants in the baſilica.

Upon the columns, the compacted beams, (h) made from three timbers of two ſeet, are placed around[7*]; and theſe, from the third columns (c) which are in the interior part, are returned to the antæ (i) that procur from the pronaos, and on the right and left touch the hemicycle.[8*]

Upon the beams, perpendicularly to the capitals, the pilæ[9*] (k) are placed, three feet high and four feet broad, on every ſide. Over theſe, other beams (ll) well wrought from two timbers of two feet, are placed around; upon which, the tranſtræ and

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(5*) The tribunal built by Romulus, in the forum, is ſaid to have been in the figure of an half moon. At chap. VII. book IV. Vitruvius calls the prodium, under the columns of round temples, a tribunal; hence we may infer, that the hemicycular tribunal here mentioned, was an erection in the nature of a podium, large altar, or pedeſtal.

(6*) Hemicyclus is uſually accepted in the ſenſe of ſemicircle; but the proportion here aſſigned it proves that the word cyclus was not applied ſolely to a perfect circle, but was expreſſive of every kind of rotund figure, whether circular or eliptical.

The proportion here mentioned very nearly agrees with that of the cycloid, a curve formed by a point, in a wheel, rolling one revolution, and conſequently whoſe baſe line is to its altitude, as the circumference is to the diameter of a circle, and as is very nearly 46 to 15; this curve, however, is thought to have been unknown to the ancients, and was firſt noticed among the moderns by Father Merſennus, and annalized by Des Cartes.

(7*) Galiani ſuppoſes theſe three timbers were diſpoſed altitudinally, making an architrave of ſix feet high, which is much too large for the columns, and beyond all example.

Perault ſuppoſes a miſtake in the text, and that four, inſtead of three, timbers ſhould be read, ſuppoſing them to have been diſpoſed, two altitudinally and two latitudinally, ſo as to form a ſquare of four feet. But, without regarding whether they were diſpoſed altitudinally or latitudinally, though my opinion leans to the latter, I ſuppoſe the architrave, both in heighth and breadth, to have been of its due proportion, and that from theſe timbers it was wrought and reduced to that proportion which ever way they were diſpoſed; for Vitruvius ſays, *Ex tribus tignis bipedalibus*; thereby implying, that the beam was wrought to its proper ſize out of or from theſe three timbers; ſuppoſing them, therefore, to have been placed latitudinally, they muſt have been reduced from 6 feet to 4 feet 5 inches and ½ (the ſize of the neck of the column) including the void of two inches to be left between each timber. In altitude, I ſuppoſe each timber to have been of ſuch a meaſure as was ſufficient to form the heighth of the architrave; for in deſcribing the Tuſcan order, at Chap. VII. Book IV. Vitruvius ſays, *The compacted beams are to be in height as much as the magnitude of the work may require, and in thickneſs equal to the top of the column.* See h, Fig. XXXV, and in ſection B B.

(8*) By theſe words, either the beams which are placed upon the columns, or the antæ of the pronaos of the temple of Auguſtus, are ſaid to touch the hemicycular tribunal on either ſide; it is no matter which is allowed, becauſe the beams are deſcribed to extend no farther than the ſaid antæ. Hence the tribunal could have been ſituated no farther back than the ſaid antæ, nor forwarder than the columns of the teſtudo. But all the preceding tranſlators, not thinking it poſſible (as I ſuppoſe) that the tribunal could have that ſituation, without obſtructing the view of the temple of Auguſtus (becauſe they imagined the tribunal to have been a receſs formed in a high wall) have placed it at the farther end of the temple, at a great diſtance from the baſilica; and Perault has added a few words to the text, to make it bear that conſtruction. But it cannot be admitted, the baſilica, being the court of juſtice, is the proper place for the tribunal; and, beſide, the words, *uti eos qui apud magiſtratus ſtarent negotiantes in baſilica ne impedirent (ſo that the negotiants in the baſilica are not obſtructed by thoſe who attend the magiſtrates)* ſtrongly imply, that the tribunal was attached to, or in the baſilica; for it is attributed only to its *curvilinear* receſſion, that it did not obſtruct the negotiants in the baſilica.

The tribunals have been before ſaid to be a kind of large pedeſtal; and therefore, being of no great heighth, could not obſtruct the view of the temple of Auguſtus, although placed before it. My opinion therefore is, that the tribunal was ſituated as ſhewn by g, fig. XXXV.

(9*) Theſe pilæ ſeem to have been a kind of blockings, lying upon the beams or architrave, in the place of the friſe, and which ſupported other beams or plates that lay in the place of the lower part of the cornice. See k, in the ſection marked B B.

capreols, being placed coincident with the zophorus[10*], antæ, and walls of the pronaos, ſuſtain one culmen[11*] (m) the whole length of the baſilica, and another (n) tranſverſely from the middle over the pronaos of the temple: ſo that it cauſes a double diſpoſition of the faſtigium[12*], and gives an handſome appearance to the roof on the outſide, and to the lofty teſtudo within. Alſo the omiſſion of the ornaments of the epiſtylium, and of the upper columns and plutei, diminiſhes the labour of the work, and ſaves great part of the expence. The columns likewiſe being carried in one continued heighth up to the beams of the teſtudo, encreaſes the magnificence and dignity of the work.

CHAPTER II.

Of the Treaſury, Priſon, and Curiæ.

Fig. XXV. THE treaſury (E) priſon (F) and curiæ[1*] (D) are adjoined to the forum, and are to be of ſuch a magnitude, that their ſymmetry may correſpond thereto. The curiæ chiefly, is firſt to be made ſuitable to the dignity of the community or city; and, if it is ſquare, its heighth is to be equal to once and an half of its breadth; but, if it is oblong, the length and breadth being added together, the half of that united ſum is given to the heighth, up to the underſide of the lacunars: alſo, at the half of the heighth, the walls are encompaſſed with coronæ of wood or plaiſter; for otherwiſe, the voice of the ſpeakers aſcending to the top, would not be heard by the audience; but, when the walls are encompaſſed with a cornice, the voice, being reflected before it is diffuſed in the air above, will be rendered ſenſible to the ears of the aſſembly.

(10*) The tranſtræ and capreols have been before mentioned to be the principal rafters and braces. They are ſaid to be coincident with the zophorus; from whence, I imagine, it is to be underſtood, that they reſted perpendicularly over the blockings or pilæ, which were diſpoſed in the place of the zophorus, or friſe.

(11*) The culmen is the horizontal piece of timber in the ridge of the roof, which we call the ridge-piece. See note 1*. chap. II. book IV.

(12*) Galiani remarks, that it is not eaſy to conceive what is meant by *duplex faſtigiorum dipoſitio*, *a double diſpoſition of the faſtigium.* The faſtigium being the triangle or pediment of the roof, continued through the whole length of the building, the ridge of which is the culmen, and it being ſaid there are two culmens, one extending the whole length of the baſilica, and another tranverſely from the middle over the pronaos of the temple, which therefore muſt croſs the former at right angles, exactly in the middle of the baſilica, there conſequently happens a double faſtigium, the one extending over the length of the building, the other over the breadth, interſecting each other in the middle, B, of the baſilica.

(1*) The curia was an hall or apartment, in which the ſenate, or legiſlature of the ſtate, aſſembled.

CHAPTER III.

Of the Theatre and its Situation.

WHEN the forum is finiſhed, then a healthy ſituation muſt be ſought for (according to the rules given in the firſt book) wherein the theatre may be erected, for the purpoſe of exhibiting the ſports on the feſtival days of the immortal Gods. For the ſpectators, with their wives and children, being detained in their ſeats by the entertainment of the games, and the pores of their bodies being opened by the inactive pleaſure, readily imbibe the air; which, if it comes from fens, or other noxious places, breeds hurtful humours in the body; but if the place of the theatre is choſen with due care, ſuch evils will be prevented The intenſe heat of the meridian muſt alſo be guarded againſt; for when the ſun fills the compaſs of the theatre, the air being confined therein, and prevented from circulating, becomes aduſt and fervid, extracting and diminiſhing the juices of the body: ſo that thoſe dangerous expoſitions are to be carefully avoided.

Fig. XXXVI. IF the foundation happens to be on a hill, the work will be more eaſily done. But if neceſſity obliges it to be erected in a plain, or in a marſhy place, the piling and ſubſtructure muſt be executed in the manner deſcribed in the third book for the foundations of temples. Upon the foundation, the degrees[1*] (a) are raiſed with ſtone and marble. The precinctions[2*] (b) are made proportional to the heighth of the theatre, and are no higher than the paſſage of the precinction is broad; for, if they are higher, they reflect and obſtruct the voice from riſing to the upper parts, not permitting the terminations and exact ſignifications of the words to reach the ears of ſuch of the audience as are ſeated

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(1*) The degrees are the ſeats of the theatres, raiſed in form of ſteps, one above another.

(2*) The precinctions are the paſſages or landing places between the ranges of ſeats, as b b, Fig. XXXVI. Vitruvius ſays they ſhould be no higher than broad; but it is remarked by all the tranſlators in general, that they cannot be of equal heighth and breadth; for as Vitruvius gives the degrees a proportion of about twice their heighth in breadth, and ſays a ſtraight line, c d, ſhould touch all their edges, from top to bottom, the precinctions muſt conſequently have the ſame proportion as the degrees. This will certainly be the caſe, if the floor of the precinction is ſuppoſed to be on a level with the adjoining degree (e); but if the floor of the precinction is ſunk a little below that degree, as it ſeems proper it ſhould be, in order that thoſe who paſs to and fro, in the precinction, may not tread on thoſe who are there ſeated; then the precinction may have the proportion Vitruvius deſcribes; for, if the floor of the precinction, b f, is ſunk ſo much below the ſaid degree as is equal to the heighth of one degree, and the clear breadth of the precinction is made equal to the breadth of two degrees, it will happen that the paſſage of the precinction, b f, will be exactly equal to its heighth, f g, on the ſuppoſition that the degrees are made exactly twice as broad as high. With regard to proportioning the precinctions to the heighth of the theatre, as Vitruvius mentions, I imagine it is to be underſtood to allude to their number, which is neceſſary to be greater in large and high theatres than in ſmaller, for it cannot allude to their magnitude, which is neceſſarily fixed in all theatres by the limited meaſure of the degrees.

above the precinctions. It is alſo to be ſo contrived that a line (c d) being extended from the lowermoſt to the uppermoſt degree, may touch the edges and angles of all the degrees from top to bottom, ſo that the voice may not be impeded.

The entrances ſhould be numerous and ſpacious, the ſuperior not connected with the inferior, but to all parts made direct, uninterrupted, and without intricacy, that, when the people are diſmiſſed from the ſhews, they may not be crouded in departing; but have, from all parts, a ſeparate and unobſtructed egreſs.[3*]

It is alſo carefully to be obſerved, that it be not a place that ſtifles the ſound, but ſuch wherein the voice may freely expand. This will be effected, if a ſituation where there is no impediment to reſonance is choſen; for the voice is flowing breath, and becomes ſenſible by the percuſſion of the air, which it actuates in an infinite number of circles; in like manner as in ſtanding water, when a ſtone is caſt therein, innumerable circles of waves ariſe from the center, and expand to a great breadth, unleſs they are interrupted by the narrowneſs of the place, or ſome obſtacle ſuffers not the impreſſion of the waves to arrive at the end; for when they are interrupted by obſtacles, the firſt recoiling diſturbs the impreſſions of the ſucceeding. Upon the ſame principle the voice acts, and cauſes ſuch circular motions in the air; but in water the circles move only ſuperficially in a level plane; whereas, in air the voice not only expands ſuperficially, but alſo aſcends gradually in heighth. As therefore in the impreſſions of the waves in water, ſo is it in the voice, when no obſtacle impedes the firſt, neither the ſecond nor the enſuing are interrupted; but all, without reverberating, reach the audience, from the loweſt to the higheſt parts.

The ancient architects therefore, following nature, and conſidering the aſcending property of the voice, thus eſtabliſhed the degrees of theatres, and contrived, by the ptinciples of mathematics and muſic, that howſoever the voice might be on the ſcene, it ſhould nevertheleſs arrive clear and melodious to the ears of the audience. For as, by inſtruments of braſs or horn, the ſounds of the chords and dieſes are rendered clearer, ſo the ancients contrived to ſtrengthen the voice by the harmonic conſtruction of the theatres.

(3*) Vitruvius gives us no farther information concerning the ſtair-caſes and paſſages, that led to the ſeveral ſtories or parts of the theatre, nor of its external conſtruction. I have, therefore, ſupplied this deficiency from the remains of the theatre of Marcellus at Rome; which, as being one of the moſt celebrated theatres of the ancients, built, and ſubſiſting in perfection, at the time of Vitruvius, I have choſen as my model; copying from thence whatever does not oppoſe the inſtructions of Vitruvius; and in this I have followed Piranesi, who ſeems to have meaſured the ruins himſelf. The plan given by Deſgodetz, being evidently falſe, he not having meaſured it himſelf, but copied it from a plan ſaid to have been taken by Baldeſari, the architect, who built the palace at preſent ſtanding on the ruins of that theatre. Serlio has alſo copied the ſame plan; which is ſo erroneous, that, even in the number of piers and arches that ſurrounded the theatre, and which may at preſent be eaſily diſcovered, it is not conformable to the original.

CHAPTER IV.

Of Harmony.

HARMONY, or the ſcience of muſic, is obſcure and difficult, eſpecially to thoſe who are unacquainted with the Greek language; for, in explaining it, it is neceſſary to make uſe of the Greek terms; becauſe ſome of them have no Latin appellations. I ſhall, therefore, as intelligibly as I am able, make ſome tranſlations from the writings of Ariſtoxenes, and ſubjoin his diagram and intervals of ſounds, that thoſe who will attentively peruſe it may underſtand it more eaſily. 1*

(1*) In order to render this chapter more intelligible, it is neceſſary to give a ſhort account of the ancient muſic, referring the reader to the diagram, fig. XXXVIII, to facilitate the conception thereof.

The ancients had eighteen notes or tones, which were contained within two octaves; but they divided their ſcale or diagram of notes, into tetrachords, or half octaves, being ſyſtems of four notes each. Tetrachords were either conjunct or disjunct. Conjunct when the higheſt note of the preceding tetrachord was the loweſt note of the ſucceeding tetrachord, making but ſeven notes in the two tetrachords. But, as in this caſe a note was wanting to complete the octave, they were obliged to add a note below the firſt tetrachord, to make the full octave or eighth, which additional note they called proſlambanomenos. Tetrachords were disjunct, when the loweſt note of the ſucceeding tetrachord was one tone diſtant from the higheſt note of the preceding tetrachord; thereby making the octave complete.

Originally, the two octaves contained no more than four tetrachords; but the ancients, afterward finding that the third tetrachord was imperfect, and that its firſt note, parameſe, did not agree in fourths with the parhypate of the ſecond tetrachord, owing to its being a disjunct tetrachord, and conſequently a full tone being between the meſe and parameſe, they were obliged to contrive another third tetrachord, which ſhould be conjunct, or a tone lower than the former, to be made uſe of occaſionally, when the harmony required it. For this reaſon, we find two tetrachords; viz. ſynemmenon and diezeugmenon, intermixed together at the beginning of the ſecond octave. The names of the tetrachords are, hypaton, or the firſt; meſon, or the middle; ſynemmenon, or the conjunct; diezeugmenon, or the disjunct; and hyperbolœon, or the higheſt: the notes or names of the tones, in the firſt tetrachord (previouſly naming proſlambanomenos) are hypate hypaton, parhypate hypaton, and lichanos hypaton. In the ſecond tetrachord, hypate meſon, parhypate meſon, lichanos meſon, and meſe. In the third tetrachord, trite ſynemmenon, paranete ſynemmenon, and nete ſynemmenon. In the fourth tetrachord, parameſe, trite diezeugmenon, paranete diezeugmenon, and nete diezeugmenon. In the fifth tetrachord, trite hyperbolœon, paranete hyperbolœon, and nete hyperbolœon.

Of theſe eighteen notes, the eight which began and ended the ſeveral tetrachords where fixed, and invariable, like our fundamental, fourth, fifth, and their octaves. The other ten, were moveable, as are our ſecond, third, ſixth, ſeventh, and their octaves. From the variation of theſe ten notes, aroſe the three ſpecies of muſic, which the ancients called enharmonic, chromatic, and diatonic; and the different colours (as they called them) of each of thoſe ſpecies.

The intervals forming each tetrachord in theſe three ſpecies, and their reſpective colours, are as follows: the enharmonic tetrachord had but one colour; it was formed by a dieſis (that is a quarter of a tone) then another ſuch dieſis, and laſtly a ditone, (*i. e.* a double tone.)

The chromatic tetrachord had three colours; molle, ſeſcuplum, and tonœum; the molle was formed by a triental dieſis (*i. e.* a third part of a tone) then another ſuch dieſis, and laſtly a trihemitone (or tone and half.)

The ſeſcuplum roſe by a ſeſquialter dieſis (*i. e.* $4\frac{1}{2}$ of a tone) then ſuch another dieſis; and laſtly, a tone and three quarters.

The toneum, by a hemitone, then another hemitone, and laſtly a trihemitone, and this laſt is the common chromatic.

The diatonic had two colours, molle and ſyntonum. The molle roſe, by a hemitone, three quadrantal dieſis, and five ſuch dieſes.

The ſyntonum by a hemitone, a tone and another tone; and this laſt is the common diatonic, ſo that every tetrachord was compoſed of two tones and half, though differently diſtributed and divided.

In the diagram, Fig. XXXVIII, I have ſhewn the ſeveral intervals, or tones, in each ſpecies, with their relation to the modern intervals and notes; but, as Vitruvius makes no mention of the different colours, I have alſo omitted them, giving only the intervals of the common diatonic, chromatic, and enharmonic, the former of which are the ſame as now uſed by the moderns.

When the voice is modified in variations, it is made either more ſhrill, or more baſs, and may be moved in two manners; of which, one is continued, the other detached. The continued voice reſts neither at the limits of the tones, nor at any other part, rendering the terminations imperceptible, although the middle of the intervals are very obvious; as when, in diſcourſe, we ſay ſol, lux, flos, nox; for in theſe neither the beginning or ends of the variations of the voice are perceptible, and it is not ſenſible to the ears where it changes from baſs to ſhrill, or from ſhrill to baſs. But in the detached it is otherwiſe; for here the voice, in varying, reſts on the limits of ſome ſounds, then on others, and makes frequent and ſenſible variations to and fro; as by the changes of the voice in ſinging, we make a variety in the modulation. When, therefore, theſe tones are changed, the points where they begin and end are made obvious by the evident diſtances of the ſounds; whilſt the others are plain in the middle only, and their limits indiſtinct.

There are three ſpecies of modulation. The firſt, that which the Greeks name *armonian*, the ſecond *chroma*, and the third *diatonon*. The harmonic modulation is the product of art. This muſic is chiefly baſs, and is much eſteemed. The chromatic, being acute and briſk in its modulation, is more ſweet and pleaſing; but the diatonic, being natural, is more eaſy in the diſtances of its intervals.

In theſe three ſpecies the tetrachords are differently divided. The harmonic tetrachords have of tones and dieſes two of each. A dieſis is a quarter part of a tone, ſo that a hemitone contains two dieſes. The chromatic are compoſed of two hemitones in ſucceſſion, and a third interval of a trihemitone. The diatonic have two ſucceſſive tones, and the third is a hemitone[2*], which terminates the meaſure of the tetrachord. Thus the tetrachords in all the three ſpecies are equally conſtituted of two tones and a hemitone; but each kind being ſeparately conſidered, every one is found to have a different diſpoſition of the intervals. Nature then has divided the ſound of the voice into the intervals of tones, hemitones, and tetrachords, and fixed their bounds, the quantity of the intervals, and the certain diſtances which conſtitute their quality. This therefore the artificers, who make inſtruments of muſic, obſerving and practiſing, as nature has eſtabliſhed, by that means give their works the proper accordance and perfection.

Tones, which by the Greeks are called *phthongoi*, are in each ſpecies eighteen; of which eight in each ſpecies are immutable and permanent; and the remaining ten, according to the uſual modulation, are moveable. The permanent are thoſe which being diſpoſed between the variable, preſerve the connection of the tetrachords, and which, in the ſeveral ſpecies, have their limits fixed. They are thus named: proſlambanonenos, hypate hypaton,

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(2*) Vitruvius mentions the hemitone, as following the two tones in the diatonic tetrachord; whereas it is generally underſtood to be before them. See the ſucceeding notes.

hypate meſon, meſe, nete ſynemmenon, parameſe, nete diezeugmenon, and nete hyperbolæon. The moveable are thoſe which are diſpoſed in the tetrachords, between the permanent, and vary their places according to the ſpecies. They have theſe names: parhypate hypaton, lichanos hypaton, parhypate meſon, lichanos meſon, trite ſynemmenon, paranete ſynemmenon, trite diezeugmenon, paranete diezeugmenon, trite hyperbolæon, and paranete hyperbolæon.

THOSE which are moveable have alſo other properties, for their intervals and diſtances are augmentable: thus, parhypate, which, in the harmonic ſpecies, is only a dieſis diſtant from hypate, in the chromatic is encreaſed to a hemitone, and, in the diatonic, to a tone[3*]; alſo, that note which is called lichanos, in the harmonic ſpecies, is a hemitone diſtant from hypate, but, in the chromatic it is augmented to two hemitones, and in the diatonic to three hemitones diſtant from hypate. Thus theſe ten ſounds, by means of their tranſitions in the different ſpecies, produce a threefold variety in the modulation.

THERE are five tetrachords: the firſt is the baſeſt, which, by the Greeks, is called *hypaton*; the ſecond is the mean, which is called *meſon*; the third is the conjoined, called *ſynemmenon*; the fourth is the diſjoined, called *diezeugmenon*; the fifth, becauſe it is the moſt acute, is called by the Greeks *hyperbolaion*.

THE concords which the human voice can naturally modulate, and which, by the Greeks are called ſymphoniai, are ſix; diateſſaron, diapente, diapaſon, diapaſon with diateſſaron, diapaſon with diapente, and diſdiapaſon, which receive their names from number; for the voice being firſt fixed on one given interval of ſound, then varying when it arrives at the fourth interval from thence, it is called diateſſaron; the fifth is called diapente; the eighth, diapaſon;

(3*) Here we find parhypate, in the diatonic tetrachord, deſcribed to be a tone diſtant from hypate. This is uſually explained to be but an hemitone diſtant; wherefore Meibonius, with Perault, and Galiani, following him, have ſuppoſed the text to be corrupted by the copyiſts; and that inſtead of *diatono vero tonum—diatono hemitonium* ſhould be read; to which latter Galiani has altered the text. I have, however, choſe to adhere to the uſual reading; and, with ſome remarks thereon, thus leave it to the ſenſe of the reader.

Vitruvius's intention is evidently to give an example of the augmentation or progreſſion of the ſame note in the three different ſpecies of muſic; it may therefore be reaſonably ſuppoſed that, if this progreſſion had not exiſted in the note, he has choſen to exemplify it by, he would not have choſen it for his example; but his choice of it is a full evidence that this note had ſuch progreſſion in his underſtanding, and abſolutely forbids a ſuppoſition of its being an error of the copyiſts; we ſee alſo that the note lichanos, which he next inſtances, perfectly agrees in this progreſſional increaſe.

It cannot then be an error of the copyiſts, and I am inclined to believe it is no error at all; but am rather of opinion that the parhypate of the diatonic tetrachord was variable in place, being ſometimes a hemitone, and ſometimes a tone, diſtant from hypate, correſponding to our C natural and C ſharp; by that means (with the other proper changes) making the key of the muſic ſometimes flat and ſometimes ſharp. According to the commonly received diſpoſition of the ancient notes, the diatonic muſic muſt have always been in the flat key; but I cannot conceive any reaſon why we may not ſuppoſe the ſharp key to have been in uſe with the ancients as well as with us; for we find the voice fixes on the intervals of the ſharp key rather more eaſily and naturally than on thoſe of the flat.

I am, therefore, of opinion, that the text is pure, or at leaſt doubtful; and, for that reaſon, Galiani ought not to have ſo haſtily admitted an alteration.

the eighth, and half the eighth, diapaſon with diateſſaron; the ninth, and half the ninth, diapaſon with diapente; and the fifteenth diſdiapaſon: for, with the intervals of the third,[4*] the ſixth, or the ſeventh, either by the ſound of ſtrings, or by that of the voice, no concord can be made; but diateſſaron, diapente, and the reſt, in order as above written, up to diſdiapaſon, have their intervals of ſound naturally agreeable and concordant. Theſe concords are generated by the union of ſounds, which are called by the Greeks *phthongoi*.

CHAPTER V.

Of the Vaſes of the Theatres.

BY means of theſe inveſtigations, the brazen vaſes, which are uſed on account of the magnitude of theatres, may be made. Theſe are ſo formed, that, upon being ſtruck, they ſound in themſelves diateſſaron, diapente, and ſo in order to diſdiapaſon. After which they are diſpoſed according to the laws of muſic, in cells formed within the ſeats of the theatres, in ſuch a manner as not to touch the wall, and have a vacancy all round them to the top of the cell. They are ſituated inverſely, and, on the ſide which is turned toward the ſcene, they are ſupported by wedges not leſs than half a foot high; alſo, oppoſite to theſe cells, in the beds of the lower ſeats, apertures are left, two feet long, and half a foot high.

Fig. XXXIX. THE diſpoſition of theſe vaſes is thus explained: If the theatre is not of a great magnitude, the range of the vaſes is fixed at the middle of its heighth, and therein are formed thirteen cells, for the twelve equal diſtances of the intervals. Then thoſe vaſes which ſound nete hyperbolœon, as before written, are firſt placed in the cells which are at the extremity of either horn. In the ſecond cells from either extremity is placed the diateſſaron (of the former) nete diezeugmenon; in the third the diateſſaron, nete parameſon;[1*]

(4*) It may not be wholly uſeleſs to mention a conjecture concerning the reaſon why the ancients did not allow the third to be a concord. They began their firſt tetrachord at that note which is called by the moderns the ſecond; viz. B. fig. XXXVIII, for they did not reckon proſlambanomenos as any part of the ſcale, conſequently our ſecond was their firſt, and our fourth their third, ſo that their third was made by the interval between our ſecond and fourth. Now, between the ſecond and fourth, there is only a hemitone major and a tone minor, which makes a defective third; for, to form a perfect natural third, a tone major and and a hemitone major is required, and then it has the proportion of five to ſix, in which only its concordance and harmony conſiſts; as therefore the ancient third wanted this proportion, it conſequently could not harmonize, or ſound concordant.

(1*) This is to be underſtood parameſe only, that note being the diateſſaron, or fourth to nete diezugmenon, as fig XXXVIII. ſhews.

in the fourth the diateſſaron, nete ſynemmenon[2*]; in the fifth, the diateſſaron, meſe; in the ſixth, the diateſſaron, hypate meſon; and in the middle one, the diateſſaron, hypate hypaton. By this regulation, the voice from the ſcene, as from a center, diverging itſelf around, and ſtriking the cavities of the ſeveral vaſes, is made more ſonorous and clear by their correſponding conſonance.

But if the theatre is of an ample magnitude, then the heighth is divided into four parts, that there may be made three ranges of cells, one for the harmonic, another for the chromatic, and the third for the diatonic. The harmonic is firſt diſpoſed at bottom, in the ſame order as deſcribed above for the leſſer theatre. In the middle range, the vaſes, which have the ſound of the chromatic hyperbolæon are firſt placed at the extremity of the horns; in the ſecond cells, the diateſſaron from this, the chromatic diezeugmenon; in the third the diateſſeron, the chromatic ſynemmenon; in the fourth the diateſſaron, the chromatic meſon; in the fifth, the diateſſaron, the chromatic hypaton; and in the ſixth, the parameſe[3*]; becauſe this laſt has a common accordance with the chromatic hyperbolæon, as the diapente; and with the chromatic meſon, as the diateſſaron. In the middle no vaſe is placed, becauſe no other tones in the chromatic ſpecies of muſic can be concordant.

Fig. XL.

(2*) Nete ſynemmenon cannot be the fourth, or diateſſaron of parameſe; this, ſeveral of the tranſlators have noticed. Meibonious and Perault have ſuppoſed it to be an error, and that diapente ſhould be read inſtead of diateſſaron, ſuppoſing it was meant to be the fifth, or diapente of the hyperbolæon; but Galiani has rectified their miſtake, by ſuppoſing that Vitruvius ſpeaks of it as the diateſſaron of the ſucceeding tone (viz. meſe) and not of the preceding tone, parameſe; the reader will alſo obſerve, by referring to fig. XXXVIII, that the notes mentioned are the terminating notes of the ſeveral tetrachords; of which, nete ſynemmenon was one.

The terminating notes of the ſeveral adjoining tetrachords were diateſſarons, or fourths, to each other, except in the tetrachords, ſynemmenon, and diezeugmenon, which were never uſed together in ſinging; it was nevertheleſs neceſſary to have both thoſe tetrachords, becauſe the melody, as well as harmony of the muſic, ſometimes required their aſſiſtance (as I have remarked in the foregoing account of ancient muſic) and the actor directed his voice to the one or the other, according to the tone required.

(3*) Vitruvius, in this caſe, names only the tetrachords, not the particular notes; but, as he ſays, parameſe is diapente, or fifth to hyperbolæon, and diateſſaron, or fourth to meſon, we may eaſily diſcover the particular notes; for the diateſſaron to parameſe muſt be lichanos meſon, and the diapente muſt be paranete hyperbolæon, not trite hyperbolæon, as Galiani has concluded; for a perfect fifth muſt have ſeven hemitone intervals; whereas between parameſe and trite hyperbolæon there are but ſix. This being ſettled, the ſeveral notes will be the following: Iſt, paranete hyperbolæon; IInd, paranete diezeugmenon; IIId, paranete ſynemenon (which is the ſame as parameſe;) IVth, lichanos meſon; Vth, lichanos hypaton; VIth, parameſe. This is ſhewn by Fig. XL. and alſo Fig. XXXVIII, where the notes uſed are marked with V.

It may be obſerved, that as the terminating notes of each tetrachord were before named, ſo here the upper notes, next to the terminating notes in each tetrachord, are made uſe of: and between the two tetrachords, ſynemmenon and diezeugmenon, there is only a tone difference, as in the former caſe; although they are mentioned as diateſſarons to one another, which has been accounted for in the foregoing note. In the following diatonic range alſo, the tetrachords only are mentioned; we, however, diſcover by the ſame means the particular notes; which prove to be the upper notes of the ſeveral tetrachords, as in the foregoing caſe; and they are in the ſame order, excepting that proſlambanomenos is uſed in the place of parameſe, and meſe is placed in the middle cell, which is entirely vacant in the former range.

Fig. XLI. In the upper diviſion, or range of cells, the vaſes formed to ſound the diatonic hyperbolæon, are placed in the firſt cells at the horns; in the ſecond cells, the diateſſaron, the diatonic diezeugmenon; in the third, the diateſſaron, the diatonic ſynemmenon; in the fourth, the diateſſeron, the diatonic meſon; in the fifth, the diateſſaron, the diatonic hypaton; in the ſixth, the diateſſaron, the proſlambanomenos; and in the middle, the meſe, becauſe this laſt has a common concordance with the proſlambanomenos, as the diapaſon; and with the diatonic hypaton, as the diapente. But whoſoever deſires more perfectly to underſtand this ſubject, may attend to the diagram at the end of the book, formed according to the principles of muſic, and which was left by Ariſtoxenus, who, with great ingenuity and induſtry, eſtabliſhed the proportional intervals of the tones. Thoſe therefore who ſtudy theſe principles, the nature of ſounds, and the cauſe of their pleaſing effects on the hearers, will be more capable of erecting theatres with due perfection.

Some may alledge, that many theatres are built in Rome every year, without any of theſe contrivances being uſed therein; but the reaſon is this: all the public wooden theatres have many boarded ſurfaces, which are neceſſarily ſonorous. This is made evident by the ſingers, who, when they would raiſe a ſtrong tone, turn themſelves to the doors of the ſcene, and by their reſonance receive a help to their voice. But when the theatres are conſtructed of ſolid ſubſtances, that is, of ſtone or marble, then the methods here explained become of uſe. If it is demanded in what theatres they are made uſe of, Rome cannot ſhew any; but the provinces of Italy, and many cities of Greece, can ſhew them. We know alſo that Lucius Mummius, who deſtroyed the theatre of Corinth, brought to Rome the vaſes of braſs, and dedicated the ſpoils in the temple of Luna. Likewiſe, many ingenious architects, who conſtruct theatres in ſmall towns, to ſave expence, make uſe of earthen veſſels to help the ſound, which, being adjuſted according to theſe rules, anſwer the intended purpoſe.

CHAPTER VI.

Of the Form of Theatres.

Fig. XXXVI. THE form of theatres is thus regulated. The central point being fixed in the middle (A,) a circle (B H) is drawn as large as the circumference of the bottom[1*] is intended; and therein, four triangles of equal ſides and intervals, are

(1*) Vitruvius does not ſay whether he means the bottom of the external or of the internal part of the theatre; but the circumſtances of the deſcription, and his making no mention of the outward conſtruction of the theatre, make it moſt probable that he means the bottom of the internal part, or orcheſtra, B H, B H.

deſcribed[2*]; whoſe extremities touch the ſurrounding line of the circle: this, by the analogy of aſtronomy to muſic, is alſo the method uſed in the deſcription of the twelve celeſtial conſtellations.

Of theſe triangles, that whoſe ſide (D D) is toward the ſcene, at the part where it interſects the curve of the circle, there determines the front of the ſcene[3*], and a line (H H) being drawn through the center (A) parallel thereto, ſeparates the pulpit[4*] (E) of the proſcene from the orcheſtra (F;) ſo that the pulpit becomes broader than that of the Greeks; for, (in the Roman theatres) all the performers act on the ſcene (or ſtage) and the orcheſtra is aſſigned for the ſeats of the ſenators.[5*] The heighth of the pulpit is no more than five feet, that thoſe who ſit in the orcheſtra may ſee the performance of all that is repreſented.

The cunei[6*] (K) of the ſpectatory of the theatre, are ſo diſpoſed, that the points of the triangles, which touch the circumference of the circle, determine the places of the aſcents and ſteps (G) between the cunei, up to the firſt precinction (b); and above that, by the alternacy of the aſcents, they alſo indicate the middle of the upper cunei (L). The angles, which direct the place of the lower ſteps, are in number ſeven; the remaining five determine the diſpoſition of the ſcene. Oppoſite to the middle one (B) ſhould be the regal doors (N); thoſe which are on the right and left (C) fix the diſpoſition of the hoſpitalian doors[7*]; and the extreme two regard the entrances of the returns (I).

(2*) This divides the circle into twelve points, by which the diſpoſition of the ſteps and paſſages are governed. The theatre of Marcellus appears to have been diſpoſed by ſixteen points; and the ſenators paſſages, Z Z, which led into the orcheſtra, were placed oppoſite to each point, excepting that they were all ſhifted out of that ſituation, half the breadth of a paſſage, from the horns, H, towards the middle, B, in order to gain a paſſage at the horns, within the limits of the ſemi-circle.

(3*) This determines the place of the front of the ſcene to be a quarter of the diameter of the orcheſtra diſtant from the ſaid orcheſtra.

(4*) The pulpit was the ſtage. The proſcene was the ſpace before the ſcene, between that and the orcheſtra, and on which the pulpit or ſtage was raiſed.

(5*) Upon comparing the figures XXXVI and XXXVII, it will be ſeen how much the pulpit or ſtage of the Roman theatres was broader than that of the Greeks; for it was the cuſtom of the Greeks to have their dancers, &c. perform in the orcheſtra, and the pulpit was reſerved for the action of the drama only; whereas, with the Romans, the whole was performed on the pulpit, and the orcheſtra was occupied by the ſeats of the ſenators.

From the orcheſtra to the firſt precinction (b) was generally made fourteen rows of ſeats, which were allotted for the equeſtrian order, tribunes, &c. all above that were the ſeats of the plebeians; and the women were, by Auguſtus, appointed to ſit in the gallery or portico (k) above.

(6*) The ſeats of the theatres were divided at regular diſtances by the ſteps, G M, in radial lines, ſo that the ſeveral collections of ſeats were in the form of wedges, broader at the top than at bottom; from whence they were called cunei, or wedges. Maffei, in his treatiſe of amphitheatres, aſſerts that the ſteps were not directed in radial lines, but in diagonals, making the baſe line of the wedge alternately at top and bottom; but as that oblique direction muſt be inconvenient, and as there is no particular reaſon for ſuppoſing ſuch an inconvenient diſpoſition, the former opinion is rather to be preferred.

The ſpectatory is that part of the theatre where the ſpectators ſat.

(7*) The ſcene was built in imitation of the fronts of the Greek houſes, in which the maſters apartments were diſpoſed in the middle, and the apartments on either ſide were allotted for the reception of ſtrangers; hence the doors on the right and left of the middle one were called the hoſpitalian doors.

THE degrees (a) of the ſpectatory, whereon the ſeats[8*] are laid, ſhould be in heighth not leſs than a foot and a palm, nor more than a foot and ſix digits[9*]; their breadth ſhould not be more than two feet and an half, nor leſs than two feet.

CHAPTER VII.

Of the Porticus and other Parts of the Theatre.

THE roof (m) of the porticus (k) which is on the higheſt degree, is to be level with the top of the ſcene; for the voice aſcending regularly to the uppermoſt degrees and roof, will, if the top is not all on a level, be loſt at the ſummit of that part whoſe altitude is leaſt, and to which it firſt arrives.

WHATEVER may be the diameter (H H) of the orcheſtra[1*], which is encompaſſed

(8*) We learn from paſſages in ſundry authors, that the ancients uſed to lay coverings of wood, or cuſhions, &c. on the ſtone ſeats of the theatres; and theſe words of Vitruvius, *Gradus ſpectaculorum ubi ſubſelliæ componantur* (*the degrees where the ſubſels or ſeats are laid*) ſeem to intimate the ſame; the word ſubſelliæ ſignifies ſome kind of ſeats, and cannot mean the degrees, or ſtone ſeats themſelves, becauſe it is ſaid they are laid on the degrees; it is therefore probable that by that word Vitruvius means the coverings of boards, cuſhions, &c. which were laid on the ſtone degrees. Perault remarks, that Dion Caſſius had overlooked this paſſage of Vitruvius, when he aſſerted that ſuch coverings were not laid on the degrees of theatres, before the time of Caligula; adding, that, as Vitruvius wrote in the time of Auguſtus, they muſt have been uſed in his time; but this is taking it for granted, that Vitruvius wrote in the time of Auguſtus; that not being certain, theſe words of Dion Caſſius become an argument in favour of the opinion that Vitruvius did not write at that time, nor till after the time of Caligula, in whoſe reign Dion Caſſius wrote. See the Remarks on the Life of Vitruvius.

(9*) A palm is a quarter of a foot: it has before been obſerved that the ancient Roman foot was 11 inches $\frac{6}{10}$ of our foot, and was divided into ſixteen digits; the heighth therefore of the degrees was not leſs than about a foot and a quarter, nor more than a foot and three eighths. In the theatre of Marcellus, the degrees were in heighth half their breadth; which proportion I have choſen to follow in my draught, fig. XXXVI, making the degrees one foot and a quarter high, and two feet and a half broad.

(1*) Vitruvius gives us no directions concerning the proportion of the orcheſtra to the whole building, that depending on the number of degrees diſpoſed around the orcheſtra, which might be determinate; it muſt, however, be ſuppoſed that ſo great a number were not diſpoſed around ſmall orcheſtras as around larger, and that ſome bounds were obſerved. The orcheſtra of the theatre of Pola, given by Serlio, and which ſubſiſted at the time he meaſured it, was, in diameter, one third of that of the whole building; and, in a theatre repreſented in the fragments of the plan of Rome, now preſerved in the Capitol, the diameter of the orcheſtra is nearly of the ſame proportion.

In the theatre of Marcellus, it was as four is to eleven, or thereabout. Barbaro, Perault, and Galiani, following each other, have, in their draughts, made it nearly as one to two, which is more than it is found in any ancient theatre, and is productive of many inconſiſtencies, as will be hereafter ſhewn. I have choſen the proportion of that of the theatre of Marcellus. Perault, and Galiani, would perſuade us that Vitruvius means the *ſemi-diameter* of the orcheſtra, where he mentions the *diameter*; becauſe the ſixth part of the diameter. which he gives to the heighth of the entrances (as they underſtand the word *itenerum*) into the orcheſtra, is, in their opinion, too great. But, notwithſtanding the reaſoning of Perault, I cannot ſo eaſily aſſent to a deviation from the expreſs words of the text. It may as well be ſuppoſed that Vitruvius means ſemi-diameter, where he writes diameter in the deſcription of the round temples, and in all other parts of his work. Perault, with an intent to prove that Vitruvius means the *ſemi-diameter*, and not the *diameter*, brings, as an argument, a paſſage from Pliny, who ſays, *that the theatre of M. Scaurus was one of the largeſt ever built, and that the lower columns of the ſcene of this theatre was 42 feet high.* Vitruvius, in the next paragraph, ſays, *ſuch lower columns ſhould be in heighth the fourth part of the diameter of the orcheſtra; according to this rule, therefore, the diameter*

by the loweſt degree, the ſixth part thereof is taken; and at the horns (H) and around the paſſage,[2*] with this meaſure (i p) ſet perpendicular, the lower ſeats are marked[3*]; and where

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of the orcheſtra of the ſaid theatre muſt have been 168 *feet. The orcheſtra of the theatre of Marcellus was* 180 *feet French. Perault then argues, that, at this rate, the theatre of Scaurus was leſs than that of Marcellus; whereas Pliny ſays, that of Scaurus was one of the largeſt ever built; but, continues he, if it is admitted that Vitruvius means ſemi-diameter, then the orcheſtra of Scaurus muſt have been in diameter eight times the heighth of thoſe columns; that is* 236 *feet;* 56 *feet larger than that of Marcellus; and thus it will better agree with the words of Pliny.*

In this calculation, Perault has made a miſtake of 100 feet; for 8 times 42 is 336, inſtead of 236, as he writes; conſequently the diameter of the orcheſtra of Scaurus was 156 feet larger than that of Marcellus; an enormous width greater than any of the few remains of theatres that have reached us will authorize, and even exceeding the internal area of the Colliſeo in its longeſt diameter (which is but 218 ½ feet, Veroneſe). The theatre of Pola, meaſured by Serlio, was one hundred and thirty feet, and another near Viterbo, one hundred and forty-one feet and an half.

But the words of Pliny will not authorize ſuch a conſtruction as Perault gives them. Pliny ſays the theatre of Scaurus was one of the largeſt ever built; from whence it does not follow that it was larger than the theatre of Marcellus; which alſo was one of the largeſt ever built, and may have been larger than that of Scaurus, without contradicting the words of Pliny.

Suppoſing then, of theſe two large theatres, that of Scaurus to have been the ſmaller, the words of Vitruvius (allowing him to mean what he ſays) will be found to agree, and the orcheſtra of Scaurus, according to this rule, muſt have been 168 feet, which is but 12 feet (or a fifteenth part) leſs than that of Marcellus; a meaſure more probable, and approaching nearer to the dimenſions of other ancient theatres.

Thus the argument of Perault turns againſt himſelf, and greatly contributes to prove that Vitruvius means the full diameter (as he writes), and not the ſemi-diameter of the orcheſtra.

(2*) This path or paſſage, around which the lower ſeats are ſaid to be marked, muſt undoubtedly be a paſſage round the back, or ſemi-circular part of the orcheſtra, H B O; for no other place can be eaſily imagined about which the lower ſeats may be marked; and ſuch a paſſage muſt have been very neceſſary, and almoſt indiſpenſible, in order to give free acceſs to the ſeveral ſeats in the orcheſtra.

(3*) Theſe lower ſeats which are marked, muſt conſequently be as high as the meaſure by which they are marked. But whether by the words *inferiores ſedes*, *the lower ſeats*, we are to underſtand two, three, or more of the lower degrees, or the loweſt degree only, as containing the lower order of ſeats, is a doubt: Perault and Galiani have underſtood it in the former ſenſe, becauſe they think the loweſt degree would, in the latter caſe, be too much elevated above the floor of the orcheſtra.

But, wherever Vitruvius means the degrees, he uſes the word *gradi*; whereas he here uſes the word *ſedes*; from whence it may be ſuppoſed that he expreſſes by that word the ſeveral ſingle ſeats contained in one degree. Alſo, as he directs theſe ſeats to be marked around the paſſage at the back of the orcheſtra, which adjoins to the loweſt degree, it is moſt natural and rational to ſuppoſe, that it is that loweſt degree which he means to be marked, and not the degrees above, which are at a conſiderable diſtance from that paſſage, and which could not be eaſily reached from thence.

The only foundation for the opinion of Perault and Galiani (who imagine that, by this mark, the heighth of the ſenators entrances are determined) is their own opinion, that, if the heighth of the loweſt degree was to be underſtood to be determined thereby, that ſuch degree would be too much elevated. But, as we know not the exact formation of the ancient theatres in this reſpect, or the neceſſity there might have been for this great elevation, ſuch opinion is not to be held in competition with the probabilities on the other ſide the queſtion, ariſing from the words of the text: it is very probable, nay even neceſſary, that the floor of the orcheſtra (i i) ſhould have been raiſed as it receded from the ſtage, that thoſe who ſat behind might ſee over the heads of thoſe who ſat before; the more it was raiſed the more convenient it would have been in this reſpect. The degrees were inclined in an angle of 22 ½; and if the floor of the orcheſtra had been raiſed to a third of that inclination (*i. e.* in an angle of 7 ½) it would not have been more than convenience required. In ſuch caſe, the loweſt degree, ſuppoſing it to have the fore-mentioned elevation, would have been but the twelfth part of the diameter of the orcheſtra above the higheſt part of the floor of the orcheſtra, which would have been no more than ſufficient to prevent the populace in the degrees from forcing into the orcheſtra among the ſenators. For theſe reaſons, therefore, the loweſt degree ought to have been conſiderably elevated; and that elevation ſhould have been always proportional to, and dependant on, the diameter of the orcheſtra, that the ſituation of the ſpectators might have been properly adapted to their diſtance from the ſtage; but the heighth of the entrances is no ways connected, or related to the diameter of the orcheſtra, and is of no conſequence to the conveniencies or appearance of the theatre. I am therefore of opinion that it is the loweſt degree which Vitruvius means ſhould be raiſed above the orcheſtra the ſixth part of its diameter.

the mark happens, there the ſuperciliæ of the paſſages are made[4*]; for thus they will have a ſufficient elevation.

THE length (I I) of the ſcene ſhould be made double the diameter of the orcheſtra.[5*] The heighth of the podium (r) from the level of the pulpit, is the twelfth part of the diameter of

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Perault objects, that, by ſuch an elevation of the loweſt degree, the dancers who performed in the orcheſtra of the Greek theatres would have been in a great meaſure unſeen; but Vitruvius does not here treat of the Greek theatres; he is ſpeaking of the Roman. Vitruvius ſays, *the Greek theatres are in many reſpects different*; and, though he does not mention this circumſtance as one of the differences, yet they muſt certainly have been different in this part; for, as the ſenators ſat in the Roman orcheſtra, it muſt have been in ſome degree inclined (as before ſaid); but the Greek orcheſtra, being for the uſe of the dancers, it muſt have been level; therefore, there not being the ſame reaſons for ſo great an elevation of the loweſt degree in Greek theatres, it was probably ſituated no higher from the level floor of their orcheſtra than it was from the higheſt part of the inclined orcheſtra in the Roman theatres.

(4*) Where the mark happens, there the ſupercilia of the paſſages are made *qua præciſio fuerit, ibi conſtituantur itenerum ſupercilia.*

The ſupercilia is, as has been explained at the third chapter of the third book, any cornice, or ſuperior moulding: it is here directed to be placed where the mark happens at the lower ſeats; which has been argued to mean the loweſt degree; and which, therefore, muſt be the place where the ſupercilia, p p, is to be placed.

But Vitruvius calls it the ſupercilia of the *paſſages*, mentioning *paſſages* (*itenerum*) in the plural. By its place it ſeems to be the ſupercilia, or cornice of the *paſſage* that goes round the back of the orcheſtra; and therefore it ſeems that the word *paſſage*, or *path*, ſhould have been mentioned in the ſingular; but it is not unuſual with Vitruvius to mention in the plural many words that appears to us to belong to the ſingular number; and the contrary (thus he mentions the architrave, or epiſtylium over a range of columns, in the plural, calling it the architraves, or epiſtyliums); ſo, if this paſſage round the orcheſtra was uſed to be divided into parts, by temporary partitions here and there between each entrance, &c. it would have been ſufficient to cauſe Vitruvius to ſpeak of it in the plural. This being mentioned in the plural, has cauſed Perault and Galiani to imagine, that by the word *itenerum* is meant the entrances or doors, z z, that lead into the orcheſtra; but firſtly, Vitruvius does not uſe that word to ſignify any kind of aperture, but for a paſſage or pathway, as in the third chapter foregoing, he uſes it for the paſſage way of the precinctions (*iteneris precinctionis.*) Secondly, He gives no deſcription of thoſe doors or entrances, nor of any of the inteſtinal parts of the fabric; but deſcribes only the diſpoſition of the ſpectatory and ſcene of the theatre. Thirdly, There appears no reaſon that ſuch doors of entrance ſhould be governed, in their heighth, by the diameter of the orcheſtra, and vary as that varies (they being rather to be numbered among the parts hereafter mentioned, whoſe meaſure ſhould be the ſame in all theatres, whether large or ſmall, as reſpecting the natural magnitude of the human body, and cannot effect the proſpect of the theatre whether greater or leſs. Fourthly, Vitruvius poſitively mentions the paſſages (by the ſame term, *itineræ*) among thoſe things that are invariable in their dimenſions in all theatres, and therefore cannot here mean that the ſame *itineræ*, or paſſages, are to be governed in their dimenſions by the different magnitude of the orcheſtra. Fifthly, That the width of ſuch doors is as neceſſary to be adjuſted as their heighth; and, as the former is not mentioned, it may well be concluded that neither is the latter. Sixthly, The heighth of the paſſage round the orcheſtra (by which alſo the heighth of the loweſt degree is determined) is neceſſarily dependent on the magnitude of the ſame orcheſtra, in order that the heighth of the ſpectators may be adapted to the diſtance of the ſtage, as before urged: from all theſe arguments, therefore, it appears much more probable that it is the ſame paſſage round the orcheſtra here meant by the word *itinerum* that was before ſignified by the word *aditus*, and that the ſupercilia mentioned is the cornice of that paſſage. Vitruvius adds, *for thus they will have a ſufficient elevation*; the word THEY muſt be underſtood to allude the lower ſeats, not to the paſſages, notwithſtanding the order of the words may ſeem to point to the latter; for the foregoing notes ſhew that it is the loweſt degree, whoſe heighth is thus regulated by the magnitude of the orcheſtra; and not the paſſages, which were no ways dependant on the meaſure of the orcheſtra.

(5*) Vitruvius ſays, *the length of the ſcene ſhould be double the diameter of the orcheſtra.*

It has been before argued that Vitruvius uſes the word diameter in its proper ſenſe; there can, therefore, be no doubt of the meaning of this ſentence. Perault and Galiani, who have before underſtood diameter for ſemi-diameter, and have alſo made the diameter of their orcheſtra equal to half the diameter of the whole fabric, are in ſome difficulty to reconcile their opinions with the authority of the antique; and to get extricated from a web, in which they have entangled themſelves, they have each choſen a different method. Perault, finding that the veſtiges of ancient theatres prove that the ſcene was ever longer than the diameter of the or-

the orcheſtra, including (in that heighth) the corona and lyſis[6*]; upon the podium columns (s) are raiſed, which, with their capitals and baſes, are equal in heighth to the fourth part of the ſaid diameter. The entablature (t) is the fifth part of the heighth of the columns. The pluteum (u) above, with its baſe and coronæ, is the half of the inferior pluteum[7*]. Above this pluteum, are other columns (v), a fourth part leſs in heighth than thoſe below; their entablature is the fifth part of the columns. Alſo, if there is to be a third order, the upper pluteum is to be the half of the middle one, and the upper columns a fourth part leſs in heighth than thoſe of the middle order; the entablature likewiſe is to be the fifth part of the heighth of the columns.

HOWEVER, in all theatres, the ſame proportions and ſymmetry may not be ſuitable. An architect ſhould therefore conſider what ſymmetry is proper to be uſed, and what proportions the nature of the place, or magnitude of the work, may require; for there are ſome things that, both in ſmall and in large theatres, muſt, on account of convenience, be made of the ſame magnitude; ſuch are the degrees, the diazomatæ[8*], plutei[9*], paſſages, ſtairs, pulpit, and tribunal[10*]; and if other things occur, that interfere with the ſymmetry, convenience muſt

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cheſtra, and that his former acceptation of diameter for ſemi-diameter, would make his ſcene no longer than the diameter of the orcheſtra: and alſo, that if he made the ſcene double the diameter of the orcheſtra, it would equal or even exceed the diameter of his whole building; has choſen to alter the text from *duplex* to *triplex*; and by that means he makes the length of his ſcene, once and half the diameter of the orcheſtra, or three ſemi-diameters. Galiani has made his ſcene no longer than the diameter of the orcheſtra, which is contrary to the authority of the antique; and is, beſides, very incommodious to the theatre; for the high walls of the returns of the ſcene, in his theatre, would obſtruct the ſight of the ſpectators; ſo that thoſe that ſat near either horn could not ſee the ſcene, or the revolving machines, but the edge of the ſtage only. The ſcene of the theatre at Pola, which was ſtanding, when meaſured by Serlio, was conſiderably longer than the diameter of the orcheſtra; ſo alſo was that of the theatre of Marcellus, as the remains of a pier and column ſtill ſubſiſting demonſtrate, as well as the draught of that theatre repreſented in the fragments of the plan of ancient Rome.

In the ſame fragments, there is alſo the repreſentation of another theatre, ſuppoſed to be that of Pompey, in which the length of the ſcene is likewiſe nearly double the diameter of the orcheſtra.

Theſe examples of antiquity, therefore, tend to confirm the foregoing arguments; and upon the whole it appears that we muſt adhere in this caſe alſo to the expreſs words of Vitruvius, and make the ſcene double the diameter of the orcheſtra, as he preſcribes. On one ſide of the ſcene, I have repreſented a veſtible, y, ſuch as the remains ſhew to have adjoined to the ſcene of the theatre of Marcellus.

(6*) Lyſis. See note 5*, chap. III. book III.

(7*) The *pluteum* and *podium* are the ſame, and ſignify what we call the *dado*. Philander has ſuppoſed the pluteum to be the entablature between a lower and higher order of columns; but the place here aſſigned them fully evinces the contrary. See note 3*, chap. I. book V.

(8*) Diazomatæ is the Greek name of the precinctions.

(9*) The plutei of the ſcene have been before ſaid to be always proportional to the diameter of the orcheſtra; theſe, which are ſaid to be always of the ſame dimenſions in all theatres, whether large or ſmall, muſt be ſituated in ſome parts of the ſpectatory, to ſerve as fences to the ſpectators, like our modern balluſtrades.

Their ſituation was probably at each precinction, and at the loweſt degree of the theatre, to ſecure the people from falling at thoſe precipices. I alſo ſuppoſe the degrees at either horn were terminated by ſuch plutei, in an inclination parallel to that of the degrees, and running up from the loweſt degree till they met the return walls of the ſcene.

(10*) The tribunal may be the place that was aſſigned for the ſeats of the prætors, or other magiſtrates, who preſided at the ſhews; for that the magiſtrates attended, and had particular places appointed for them, we may learn from Suetonius, who tells us, that Auguſtus ordered that the veſtals ſhould ſit at the podium, oppoſite to the prætor.

not be neglected. Likewiſe, if the materials, ſuch as marble, timber, and other things, which are uſed in buildings, ſhould be ſcarce, the work muſt be a little reduced or enlarged, till it properly agrees with the intention. This will be duly obſerved, if the architect is experienced, and is not deficient in ingenuity and judgment.

THE ſcene is to be ſo contrived as to have doors (N) in the middle, with regal decorations: to the right and left the hoſpitalian doors (P), and near by[11*] the places allotted for the ſcenery. Theſe places the Greeks call *periactous*, becauſe therein are the revolving machines[12*] (R), having three ſides, and on each ſide a different kind of repreſentation, which, when there are any changes of the fable, or on the arrival of Gods with thunder, are ſuddenly turned, and change the kind of repreſentation in front. Near this place are the ingreſſes (I) of the returns; one ſuppoſed to lead from the forum, and the other from the country.

CHAPTER VIII.

Of the three Kinds of Scenes, and of the Theatres of the Greeks.

THERE are three kinds of ſcenes; one is called tragic, another comic, and the third ſatyric. Theſe are different and diſſimilar to each other. The tragic is compoſed of

(11*) Perault has tranſlated *ſecundum* (which Vitruvius always uſes for *near*, or *adjoining*, &c.) *dɛ̈riere*, or *behind*, ſo making it to be underſtood that the revolving machines were placed behind the aperture of the doors, which would infallibly prevent the entrance of the actors, and render the doors uſeleſs; at leaſt thoſe machines muſt be turned every time an actor is to croud paſt them.

Vitruvius ſays they are near the hoſpitalian doors; and the order he obſerves in deſcribing the parts of the ſcene, gives us to underſtand, that they are on that ſide the hoſpitalian doors which is next the returns of the ſcene.

Galiani has diſpoſed them on either ſide the orcheſtra, in a line reaching from the horns thereof to the ſcene, in the manner of our ſide-ſcenes. This diſpoſition may ſuit very well with the theatre of Galiani, who makes the length of the ſcene to be no more than the diameter of the orcheſtra; but, as it has been ſufficiently proved that the ſcene ought to be in length double the diameter of the orcheſtra (by which length, the view from the ſpectatory is enlarged, and the ſtage better ſeen by the greater part of the ſpectators) that diſpoſition is very unſuitable for theatres ſo formed, as it hides the remaining length of the ſcene entirely, and obſtructs the view of the center of the ſtage, the regal and hoſpitalian doors, as well as thoſe of the returns from the ſpectators who ſit near, or even at ſome diſtance from, the horns of the theatre.

As the order Vitruvius obſerves in deſcribing the ſcene, is from the middle to the extremes, on the right and left, mentioning all the parts on the face of the ſcene in their order, in his way; and, as he mentions the ſaid revolving machines between the hoſpitalian doors and the entrances of the returns; it appears to me that their ſituation was moſt likely on the face of the ſcene, between the ſaid entrances; as ſee R R, Fig. XXXVI.

(12*) We know little of the nature of theſe machines more than what we may learn from this paſſage of Vitruvius; the ancients had other kinds of ſcenes, which were drawn before each other, like our modern ſcenes, and to which they gave the title of *ductilis*, as theſe that turned upon an axis were called *verſatilis*.

columns, faſtigiums, ſtatues, and other majeſtic objects. The comic has the appearances of private edifices, balconies, and windows, diſpoſed in imitation of the manner of common buildings. But the ſatyric is adorned with trees, vallies, mountains, and other rural objects, repreſented in topiarian[1*] work.

Fig. XXXVII.

In the theatres of the Greeks the ſame methods entirely are not purſued; for, firſt, in the circumference (B H H) at bottom, where, in the Latin theatres, four triangles are formed, in theſe there are three ſquares, the angles of which touch the circumferent line; and that ſquare whoſe ſide (D D) is next to the ſcene, and interſects the curve of the circle, at that place determines the end of the proſcene; and from that point, at the extreme circumference (B) of the circle, a parallel line (P P) is drawn, on which the front of the ſcene is erected. Alſo, through the centre (A) of the orcheſtra, a line (H H) parallel to the line of the proſcene (D D) is deſcribed; and where it interſects the circular lines to the right and left, in the horns of the ſemicircle, centers (H H) are formed; and the compaſſes being fixed in the right horn (H), from the left interval (H), a circular line (H E) is drawn to the right ſide (E) of the proſcene[2*]; likewiſe the central foot being placed in the left horn (H), a circular line (H F) is drawn from the right interval (H) to the left ſide (F) of the proſcene. By this deſcription with three centers (H A H) the orcheſtra, and the receſs of the ſcene, in the Greek theatres, become larger; and the breadth (D P) of the pulpit, which they call *logeion*, is ſmaller[3*]; becauſe, with them, the tragic and comic actors perform on the ſcene, and the other performers act in the orcheſtra. Hence the Greeks

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(1*) The planning and planting of gardens, grounds, &c.

(2*) I am of Galiani's opinion, that the right ſide of the ſpectatory muſt be underſtood to be the left ſide of the proſcene; and the contrary; otherwiſe it is impoſſible to reconcile the circumſtances of the deſcription.

The preceding tranſlators, who have ſuppoſed the right ſide of the ſpectatory to be alſo the right ſide of the proſcene, have not been able to underſtand the deſcription themſelves; and the lines they draw, in attempting to explain it, are without uſe or meaning.

(3*) I am alſo of opinion, that not only the orcheſtra was by theſe centers, H H, continued from the horns of the ſemi-circle to the proſcene, but that all the degrees around the orcheſtra were alſo continued by the ſame centers to the proſcene, as I have ſhewn in my draught, Fig. XXXVII.

I can imagine no objection to this enlargement of the theatre; the words of the text do not oppoſe it; nor do they imply that the degrees muſt terminate at the horns of the ſemi-circle. In the Roman theatre, they terminated at that place; but, in the Roman theatre, the proſcene began there; and, as the degrees terminated againſt the line of the proſcene, in the Roman theatre, it is ſome reaſon for ſuppoſing they ſhould do the ſame in the Greek theatre. The degrees ſurrounded the whole orcheſtra in the former, why not therefore in the latter: it appears abſurd to make the orcheſtra extend forward to the front of the proſcene, unattended by the degrees, as Galiani has repreſented it. To what purpoſe is the ſpace between the horns and the proſcene applied? And how is it to be diſpoſed of? Beſides, Vitruvius, in the foregoing chapter, deſcribes the orcheſtra to be encompaſſed by the loweſt degree; we cannot ſuppoſe he means a part of the orcheſtra; his words imply the whole circumference, from proſcene to proſcene.

Galiani has not only made the degrees terminate at the horns, H, but has alſo incloſed them with a high wall, reaching to the top of the theatre; by which means, thoſe who ſat near the horns could not ſee the whole orcheſtra; nor, indeed, much farther than the center, A; a great number would be prevented from ſeeing the front of the ſtage, and a ſtill greater number could never ſee the hoſpitalian doors, or ſcenery. Inſtead of a high wall, a pluteum or balluſtrade running up the degrees, at their termination againſt the proſcene, would have been a ſufficient fence, and not have obſtructed the ſight of the ſpectators.

Fig. XXXVII. diſtinguiſh them by the names of ſcenici and thymelici. The heighth of this logeum ſhould not be leſs than ten feet, nor more than twelve. The ſteps (C) between the cunei (K), and ſeats up to the firſt precinction (b), are diſpoſed oppoſite to the angles of the ſquares. From that precinction to the ſecond, they are directed in the middle between the former, and ſo on to the top, making as many changes as there are precinctions, and always enlarging.

When all theſe things are carefully and judiciouſly adjuſted, then great care muſt alſo be taken, that the ſituation choſen be ſuch, that the voice may exert itſelf with facility, and not recoil, or convey the ſignifications to the audience indiſtinctly; for there are ſome places naturally obſtructive of the motion of the voice; as the diſſonant, which the Greeks call catechontes; the circumſonant, which are called periecontes; and the reſonant, called antechontes; but the conſonant they name ſynechontes.

The diſſonant are thoſe where the firſt ſound having aſcended upward, is repelled by ſome ſuperior ſolid body, and recoiling downward, counteracts the aſcent of the enſuing ſounds; the circumſonant are ſuch where the excited voice revolving round, ſettles itſelf in the middle, without ſounding the terminations, and is there loſt, leaving the ſignifications of the words uncertain; the reſonant are ſuch wherein the ſound, meeting with ſome ſtrong repercuſſion, reverberates, and cauſes the terminations to be heard double; but the conſonant are thoſe wherein the aſcending ſound, being ſtrengthened from below, the words are clearly and diſtinctly conveyed to the audience.

Thus, if in the choice of the ſituation due care is taken, the effect of the voice, and the utility of the theatre, will be improved. Concerning their forms, which are different to each other, it is to be obſerved, that thoſe which are deſigned from ſquares, are uſed by the Greeks; and thoſe from equilateral triangles, by the Latins. By theſe inſtructions theatres may be erected with due perfection and propriety.[4*]

(4*) After this deſcription of ancient theatres, it may not be improper to make ſome reflections concerning their application to modern uſe, and how far their mode of conſtruction may be conveniently imitated in modern theatres.

The ancient ſtage was limited by the fixed ſcene to a very ſmall proportional depth, or extent from the front; and the whole action was performed near the front of the ſtage.

The place of action, therefore, being confined to one ſpot, the ſpectators might very properly and conveniently be diſpoſed around it, in the form of a ſemi-circle.

But the machinery, changes of the ſcene, and other repreſentations which have been introduced in our modern theatres, require a great extent of ſtage. The place of action in modern theatres being, therefore, variable to all diſtances, from the front of the ſtage, the ſpectators cannot be conveniently ſituated round any certain point, ſo as to have their ſight always directed to the place of action; but, to have a perfect view of the whole ſtage at all diſtances, the ſeats muſt be diſpoſed in lines parallel to the front thereof, terminated at either end by a line at right angles, drawn from either ſide of the ſtage; or at leaſt the lines of the ſeats ſhould never exceed ſuch a portion of a curve as may be formed by a center, at the utmoſt diſtance of the ſtage, and terminated on the ſides by radial lines drawn from the ſame point, interſecting the front of the ſtage at either end; for, by this diſpoſition, every part of the ſtage will be expoſed to the view of every ſpectator.

But as one part of the entertainment of our theatres conſiſts in the ſight of the company, to which the ſemicircular diſpoſition of the ſeats is beſt adapted, it may be allowable to

CHAPTER IX.

Of the Porticos behind the Scenes, and of Ambulatories.

BEHIND the ſcenes, porticos are erected, for the people to retire to, in caſe ſudden rains ſhould interrupt the ſhews; and alſo to allow room for the managers to prepare the chorus. Such are the Pompeian portico, the portico of Eumenices, and of the temple of Bacchus at Athens; alſo the odeum, which is on the left hand, in returning from the theatre, and which Pericles raiſed at Athens with ſtone columns, and crowned with the wrecks and antennæ of the veſſels taken from the Perſians; this was burnt in the Mithridatic war, and reſtored by king Ariobarzanes. There is likewiſe the ſtrategeum of Smyrna, and the portico of Tralles, on both ſides, like the ſcene upon the ſtadium; and ſo in many other cities where they have had judicious architects, porticos and ambulatories are ſeen adjoining to the theatre. Theſe (porticos) ſhould be double, and have outwardly Doric columns, with the epiſtylium and entablature according to the modulary proportions of the perfect Doric. Their breadth

Fig. XXXVI. and XXXVII.

prefer a diſpoſition that, though not ſo perfectly adapted to one, may partake of a moderate and equal ſhare of both.

The diſpoſition that, I conceive, would anſwer this intention is that I have ſhewn in the figures XLII. XLIII. and XLIV. where the front line of ſeats is a ſemicircle, whoſe center is in the front of the ſtage, as in the Roman theatre, and the ſeats behind are turned by the ſame center, but extend no farther round than to lines drawn from either horn of the ſemicircle, at right angles with the front of the ſtage. By this means the lines of the degrees becoming, as they recede, portions of larger circles, approach more to a ſtraight line, ſo that the nobles and perſons of fortune, who ſit in the boxes in the ſemicircle, will be beſt diſpoſed for the ſight of each other, while the populace in the galleries will be better ſituated for the ſight of the performances; each however partaking of a ſufficient ſhare of the convenience of the other diſpoſition.

The ſemicircle, I alſo imagine, gives a proper diſtance to the ſpectatory from the ſtage, and a moderate ſize to the orcheſtra or pit, which ſhould be no larger than is neceſſary to give a juſt diſtance to the front of the ſpectatory.

The degrees, or ſeats of the galleries, may be diſpoſed in the ſame manner as in the ancient theatres, riſing as they recede: all the other parts are ſufficiently explained by the draught.

The middle paſſage, A, leads to the ſemi-circle of boxes, B; the ſtairs, C, lead to the upper row of boxes; the royal apartment, E, in the middle, takes the heighth of both rows of boxes; the ſtair-caſes, F, at either end, lead to the galleries. After mounting the firſt and ſecond aſcent, F and G, the people return, by a paſſage over the firſt aſcent, F, into the paſſage, H, from whence they enter by the door, I, into the precinction of the firſt gallery, K.

To go to the ſecond gallery, L, they mount the third aſcent, marked M, in the elevation, and which is over the ſecond aſcent, C, and then turn again into another paſſage, which is over the former paſſage, H, from whence they enter by the door, N, into the ſecond gallery.

To go to the gallery, O, within the portico, at the top of the theatre, they aſcend the ſtairs, P, which brings them to the hinder part of the portico.

Seats on the ſtage ſhould never be permitted; and ſeats on the flanks of the theatre are very inconvenient; but, if they ſhould be required, they may be made between the columns, R, over the paſſage, H; a ſmall ſtair-caſe, Q, being made at the end of the ſaid paſſage, to lead to them from the level of the firſt ſtory; or otherwiſe the ſpaces between the ſaid columns may be adorned with paintings of dramatic ſubjects, &c.

A ſmaller theatre might be built on the ſame plan, by wholly omitting the ſecond gallery, L, and bringing the portico, O, down to the end of the firſt gallery, as is ſhewn by the figures XLV and XLVI.

ſhould be ſo determined, that whatever may be the heighth of the exterior columns (W), ſo much ſhould be the breadth from the outſide of the columns at the bottom, to the middle (x); and from the middle, to the walls (C), which incloſe the portico walks: the middle columns (x) are to be a fifth part higher than the the exterior, and are either of the Ionic or Corinthian kind.

But the proportions and ſymmetry of theſe columns are not to be the ſame as preſcribed for ſacred edifices; for, in the temples of the Gods, there ſhould be an appearance of gravity; but, in porticos, and ſuch other works, of gaiety.[1*] If the columns therefore are of the Doric kind, their heighth, including the capital, is divided into fifteen parts, one of which makes the module, by which module the proportions of the whole work is to be regulated. The thickneſs of the column at bottom is two modules, the intercolumns five and a half; the heighth of the columns, without the capitals, fourteen modules; the heighth of the capitals one module, and their breadth two and a ſixth. The modulation of the other parts is the ſame as is written in the fourth book for ſacred edifices.

But if Ionic columns are uſed, the ſhaft, excluſive of the baſe and capital, is divided into eight parts and a half, of which one is given to the thickneſs of the column. The baſe, including the plinth, is made half the thickneſs of the column, and the capitals are formed in the manner deſcribed in the third book.

If they are Corinthian, the ſhaft and baſe is to be the ſame as in the Ionic, but the capital is made according to the rules written in the third book. Alſo the adjection, which is made in the ſtylobatæ, for the unequal ſcamilli, is taken from the deſcription written in the third book; and the epiſtylium, cornice, and all the other parts relative to the columns, are explained in the before written books.

Fig. XXXVII. The middle ſpaces (M), within the porticos, which are uncovered, are to be planted; for the hypæthral walks are exceedingly beneficial, and chiefly to the eyes; becauſe the air from the green plants, which is ſubtilized and attenuated by the motion of thoſe bodies, entering therein, clears the view, and, drawing from the eyes the groſs humours, leaves the ſight pure and acute; beſides, when the body, by the exerciſe of walking, grows warm, the air extracting the humours, diminiſhes corpulency, and thins and diſſipates whatever is ſuperfluous in the body. This is known by conſidering, that in covered places, where there are fountains of water, or the earth underneath abounds with ſprings, no cloudy vapours ariſe; but in open and uncovered places, as ſoon as the rays of the riſing ſun

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(1*) This is one, amongſt ſeveral paſſages in Vitruvius, which authorize a variation in the proportions of the orders, according to the purpoſe and deſtination of the work. There are, without doubt, ſome limits which ſhould not be exceeded; theſe, Nature and Reaſon muſt determine: but it cannot be neceſſary, nay it muſt even be erroneous, to adhere in all caſes indiſcriminately, to any certain meaſures or proportions. See the preface.

ſtrike the earth, they excite abundant vapours from the humid ſoil, conglobing and exhaling them upward. If therefore it is found that, in uncovered places, the air extracts the hurtful humours from the body, in the ſame manner as clouds are drawn from the earth, I think it cannot be doubted that the ambulatories in cities ſhould be ſpacious, agreeably planted, and be alſo open and uncovered.

But in order that they may be always dry and clean, they ſhould be made thus: They muſt be dug and emptied a proper depth; on the right and left drains are made, and in the walls which are toward the ambulatory, pipes are inſerted, inclining into the covering of the drains; this done, the place is to be filled with coal, and upon that the gravel for the walks is to be ſtrewed and levelled. Thus, by the natural ſuction of the coal, and the pipes infixed in the drains, the water is drawn off, and the walks will always remain dry and without moiſture.

In theſe buildings the ancients alſo made repoſitories for the neceſſaries of the city; for in ſieges, all things are more eaſily obtained than fuel; ſalt may be eaſily imported beforehand; corn, publicly or privately, may be ſoon collected, and, if it fails, fleſh, herbs, or pulſe may be ſubſtituted in its ſtead; water may be obtained from wells, and, in ſudden rains, received from the roofs; but fuel, which is abſolutely neceſſary for the preparation of foods, is with difficulty and trouble provided; for it is ſlowly collected, and quickly conſumed. In ſuch times therefore theſe ambulatories were opened, and a ſpace allotted to each tribe. Thus theſe uncovered ambulatories anſwer two excellent purpoſes; the one, health in peace; the other, preſervation in war. By theſe rules, therefore, not only the ambulatories behind the ſcenes of theatres, but alſo thoſe which, for the convenience of great cities, are erected to all the temples of the Gods, may be conſtructed. Having now ſufficiently explained theſe things, an account of the diſpoſition of baths follows next.

CHAPTER X.

Of the Diſpoſition and Parts of Baths.

Fig. XLVIII. FIRST, the warmeſt poſition is to be choſen, ſuch as is ſheltered from the north and north eaſt; and the caldaria[1*] and tepidaria[2*] ſhould be lighted from the winter weſt[3*], or, if that is oppoſed by the nature of the place, from the ſouth;

(1*) The hot bath, or ſudatory.

(2*) The warm apartment.

(3*) Meaning that point in the horizon where the ſun ſets at the winter ſolſtice, that is nearly ſouth-weſt; this is the poſition of all the Roman thermæ, whoſe ruins are ſtill to be ſeen; their fronts are north-eaſt; and back fronts, in which the baths probably were diſpoſed, are ſouth-weſt.

becauſe the principal time of bathing is from noon to the evening. It muſt alſo be obſerved, that the caldaria for the women ſhould be contiguous to that for the men, and be expoſed to the ſame aſpect; for thus the ſame hypocauſtum[4*] may ſuffice for the vaſaria[5*] of both.

Fig. XLVIII. and L. Over the hypocauſtum three caldrons are diſpoſed; one the caldarium (c), another the tepidarium (b), and the third the frigidarium[6*] (a). They are ſo diſpoſed, that as much water may flow into the tepidarium, as runs from thence into the caldarium, and in like manner from the frigidarium into the tepidarium[7*]; and the contours of the channels[8*] are heated by one common hypocauſtum.

Fig. LI. The ſuſpenſures of the caldarii are thus formed: Firſt, the bottom (a) is to be paved with foot and half tiles, inclining toward the hypocauſtum, that if the fuel ſhould be ejected, it may meet no reſiſtance inwardly, but roll back again to the entrance of the furnace; for thus the fire will naturally ſpread itſelf under the ſuſpenſion. Upon this eight inch earthen pillars (b) are raiſed, and ſo placed, that tiles of two feet may reſt thereon;

(4*) The furnace.

(5*) The vaſaria I ſuppoſe to be the apartment containing the veſſels wherein the water was heated. This paſſage gives us to underſtand that each hot-bath had its reſpective ſet of cauldrons.

(6*) The veſſels containing the hot, warm, and cold water.

(7*) Various are the conjectures of the commentators concerning the manner in which theſe cauldrons were ſituated and connected together: but the deſcription is not ſufficiently determinate to enable us to fix on any one. I ſhall, however, give the repreſentation of an ancient painting found in the thermæ of Titus, firſt publiſhed in Maffei's collection, wherein theſe vaſes, or cauldrons, appear diſcharging the water into one another, as Vitruvius deſcribes. See Fig. XLIX.

Galiani has ſo diſpoſed theſe cauldrons, that the frigidarium, though the moſt diſtant from the fire, muſt be heated equally with the caldarium; for the pipe of communication, which he has placed at bottom, unites the water in the three veſſels into one body; by which connexion, the moſt diſtant part is equally heated with the neareſt, the whole maſs making a circulation to and from the fire. This, I imagine, he has been led into by a deſire to ſituate the vaſes all on a level; but the vaſes may be diſpoſed all on a level, and the current of water from one to another preſerved, as Vitruvius directs, without placing the pipe, which diſcharges the water from one into the other, at the bottom of each veſſel. If the diſcharging pipes are made ſo much higher than one another as is equal to the diameter of one of the ſaid pipes, it will be ſufficient to anſwer the end. The pipes, being then placed at the top of each veſſel, will convey the water from the frigidarium to the other veſſels, without any poſſibility of the heat from the caldarium being communicated to the frigidarium, &c. See Fig. L.

With regard to the mode of ſupplying the baths, I imagine that, from the reſervatory, or aqueduct, a conſtant ſtream of freſh water ran into the frigidarium, where it became warm; from thence it ran into the tepidarium, in which it was made hot; and then ran into the caldarium, where it received the greateſt degree of heat; and from thence, a continual ſtream of hot water was conveyed by pipes into the bath, being tempered by a mixture of cold water, from the reſervatory, to the degree required. From the bath alſo, the ſame quantity of water that entered continually ran off, by waſte pipes or drains, at the top; thus, the dirt and impurities floating on the ſurface, and ariſing from the bodies of thoſe who bathed, was continually carried off by the ſtream, leaving the water of the bath always pure and clean.

(3*) *Alvei*, I tranſlate *channels*; for it is doubtful whether Vitruvius means by this word the vacuities of the cauldrons, or that of the baths, or ſome other kind of voids, or channels (for it is thought there were channels, or flews of maſonry, or fictile ware, uſed to convey hot and warm air into the cadariæ and tepidariæ, and which were alſo brought from the ſame hypocauſtum).

A little farther, alveus is mentioned with labrum; and by ſome ſuppoſed to ſignify the ſame thing (that is, the bath itſelf). It is certain that it is not there uſed for the cauldrons; but neither is it (in my opinion) for the void of the bath, as is obſerved at note 11*.

the height of the pillars is two feet; they are made with clay, having hair beaten therein; and upon theſe two-feet tiles (c) are laid, which ſupport the pavement.[9*]

Concerning the floors, if they are of maſonry they will be moſt ſerviceable; but if they are of timber they muſt be plaſtered underneath, which is to be done thus:—Iron bars or arcs are made, and, with prongs of iron, hung to the floor, very cloſe together. Theſe bars or arcs are ſo diſpoſed, that tiles without margins may lie between every two, and the whole arch is to be thus completely braced with iron. Then the joints on the upper part of theſe arches are to be ſtopped with beaten clay and hair; the under part, which is toward the pavement, being firſt plaſtered with pounded tiles and lime, and afterward made ſmooth with ſtucco or white plaſter. If, in the hot apartments, theſe arches are made double, they will anſwer the end better; for the humid vapours cannot then corrupt the timbers in the flooring, but they will be diſſipated between the two arches.

Fig. XLVIII. The magnitude of the baths ſhould be ſuited to the number of the people. They are thus proportioned:—A third part being deducted from the length, the remainder makes the breadth, excluſive of the ſchola[10*] (d), of the baſon (f), and the channel[11*] (e). The baſon (f) is ſo diſpoſed under the light, that thoſe who ſtand around may

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(9*) It has been doubted whether Vitruvius means, by the *caldarii* here mentioned, the cauldrons containing the hot water, and which he has juſt before mentioned, or the hot bathing apartments; for he gives them both the ſame appellation. Barbaro, in his tranſlation, determines for the former, which was once myopinion: but I am now convinced that Galiani's opinion is juſt, and that the latter is to be underſtood; for the remains of ſeveral antient baths, of late years diſcovered, ſhew that the floors of the hot apartments were ſupported (or ſuſpended, as it is termed), in the manner here deſcribed.

Vitruvius has not however informed us how the cauldrons were ſupported over the furnace. In the antient painting, *Fig. XLIX.* they are repreſented ſtanding upon arches, covering ſmall channels or flues underneath, where the fire appears: this indeed agrees very well with the latter words of the preceding paragraph—*teſtudineſque alveorum ex communi hypocauſi calefacientur*; for the word *teſtudines*, which I have rendered *contours*, generally means arched coverings of ſome kind. Vitruvius alſo ſays theſe *teſtudines* are heated by the *hypocauſtum*, and this appears to be the caſe by the painting; ſo that the mode of ſupporting the cauldrons may have been as thereby repreſented. This obſervation may aſſiſt the preceding note (8), concerning the *alvei*; for if the *teſtudines*, as is probable, be the arched tops of the channels or flues of the *hypocauſtum*, the *alvei* muſt ſignify thoſe flues themſelves. That however cannot be the only meaning of the word *alveus*, as will appear here following: it was probably a general term, applied to any kind of hollowed or channelled object.

This antient painting alſo ſhews that the hypocauſtum extended under ſeveral apartments, the hot-bath, ſudatory, laconicum, and tepidaria, as well as being under the cauldrons; and the ſame fact has been found to be exemplified in the remains of moſt of the antient baths that have been diſcovered.

(10*) The *ſchola* is the walk or pathway, around the baſon of the bath, as Vitruvius preſently intimates.

(11*) At note (8) I have expreſſed my uncertainty concerning the alvei, and at note (9) given my ideas of them in that paſſage. But in this the word *alveus* muſt mean ſomething different. It cannot be the great baſon or labrum itſelf, of the proportion of which Vitruvius is ſpeaking; for, a few lines farther, he ſays it is but ſix feet wide; or, when the pulvinus and lower ſtep are deducted, but four feet: which is not probable to have been the width of a public bath among the antient Romans. Pliny deſcribes his own private bath at Laurentinum to have been large enough to ſwim in; and in ſome of the antient baths the baſon has been found to be of a conſiderable ſize. That diſcovered in the city of Bath, in the year 1755, had a baſon 19 feet 3 inches broad, 27 feet 3 inches long, and 4 feet deep; and the baths lately diſcovered at Baden-Weiler in Germany, publiſhed by Governor Pownal, in the Provincia Romana of Gaul, appear, by the ſcale, to be of nearly the ſame dimenſions.—Theſe latter are the moſt complete examples that have come to our knowledge, and well deſerve a full and accurate delineation.

It is highly probable then that the word *alveus* does not here mean the labrum or great baſon; but it muſt certainly mean ſome part within the bathing-room, from the manner of its being mentioned in the deſcription thereof. The words *præter ſchoiam labri & alvei—excluſive of the ſchola of the baſon and of the alveus*, give us to underſtand that the alveus had a ſchola as well as the baſon: it is, farther on, ſaid to be between the wall and pluteum; it muſt then have adjoined the wall, and have had a pluteum or fence on the oppoſite ſide. This circumſtance, the general meaning of the word, and a lower ſtep being mentioned, and ſaid to occupy a portion of it, argue it to have been ſome excavation below the reſt of the floor; the fence on one ſide being a requiſite guard in ſuch a caſe, the wall ſerving inſtead on the other ſide. Theſe circumſtances excite the idea that it was a ſmaller bath or baſon (e), adjoining the wall of the room, on one ſide of the great baſon (f); but with a path or ſchola (g) between the two, which might be deemed the ſchola of the alveus.

The uſe of ſuch ſmaller baths can only be conjectured: various reaſons might make it proper to ſeparate ſome perſons from the generality, and they might be for their uſe; or for children, for whom the common bath might be too deep. Such, however, were certainly in uſe: the antient painting, *Fig. XLIX.* repreſents them. They were found in the antient baths of Baden-Weiler, twenty inches only in depth; and Vitruvius, book ix. chap. 3, mentions ſuch by the name of *ſolium*. This latter muſt have been a ſmall baſon, ſince the body of one man cauſed it ſenſibly to overflow: and the mention of overflowing is a probable evidence that it was not one of thoſe ſunk within the floor, but raiſed above, or ſtanding on it; for the former could not overflow, as the water muſt run into them again. The term *ſolium* therefore might be applied

not obſcure it with their ſhadows. The ſcholæ of the baſons ſhould be made ſo broad, that, while the firſt comers are bathing, the ſurrounding ſpectators may wait commodiouſly. The breadth of the channel (e), between the wall and the pluteum[12*], is not leſs than ſix feet; for the cauſeway and ſtep at bottom occupy two feet.

The laconicum[13*] and ſudatories adjoin to the tepidaria. Their height, to the bottom of the curve of the hemiſphere, is equal to their breadth, and an aperture for light is left in the middle of the dome, from whence a brazen ſhield hangs by a chain, by the raiſing and lowering of which, the heat of the ſudatory is tempered. This aperture ſhould be made circular, that the heat of the fire and vapour may, from the middle, diffuſe equally round the curve of the dome.

CHAPTER XI.

Of the Conſtruction of Paleſtræ.

Fig. LII. ALTHOUGH paleſtræ are not of Italian uſage, it ſeems to me proper to treat of their conſtruction, and of the manner in which they are built by the Greeks. In three porticos (A B C) ſpacious exedræ, having ſeats, are erected, in which the philoſophers,

to ſuch ſmall baſons as were elevated above or on the floor, and *alveus* to thoſe that were ſunk within it.

The remains of the baths at Baden inform us of ſome other particulars in the œconomy of antient baths, which may not be improperly here noticed. The great baſons were excavations below the floor of the room, as was alſo the caſe in that diſcovered in the city of Bath; and along the two ends of the baſons were four ſteps, each a foot in height, to deſcend into them; but on the two longeſt ſides were only two ſteps, two feet high each. The water was introduced through a hole in the face of the upper ſtep; and a leaden pipe was found at the bottom, for the purpoſe of diſcharging the whole body of water. The two hot baths, one for the men, the other for the women, were adjoining, as Vitruvius recommends; and the hypocauſtum was not between them, as repreſented in *Fig. XLVIII.* but behind them, and adjoining both. The ſudatories were on each ſide of the hypocauſtum, each having a laconicum adjoining, which communicated both with the ſudatory and the hot-bath.

(12*) What the *pulvinus* was, is not explained; Vitruvius gives the ſame appellation to the flank of the Ionic volute. It may have been ſome ſtep or ſeat within the bath, or the ſtone capping on the wall incloſing the baſon.

(13*) Perrault, Barbaro, and others have conceived the laconicum and ſudatory to have been the ſame apartment; which Galiani properly corrects, for in the following chapter they are clearly diſtinguiſhed. It may be collected from the words of Vitruvius here, and at the 10th chapter of the ſeventh book, that the laconicum was a ſmall room, with a domed or hemiſpheric cieling: but many particulars regarding its ſize, communication with the ſudatory, and introduction of the heat, are left unexplained; nor is it ſufficiently elucidated by any example hitherto diſcovered. In the antient painting, *Fig. XLIX.* it appears as a ſmall ſtove within the ſudatorium; and the ſhield hangs over, as if to cloſe occaſionally a tube in the floor through which the flames iſſue. The deſcription of Vitruvius, however, gives an idea that the ſhield or ſhutter was applied to the aperture in the dome above. The communication with the furnace was probably through ſuch an aperture in the floor; but whether the flame, or only the heat, was admitted, is not aſcertained. If the flame, and there was a communication between the laconicum and ſudatorium, this latter muſt have been filled with ſmoke, unleſs it paſſed away through the aperture in the dome above; and, if ſo, the heat muſt have paſſed with it. But if heat only was admitted into the laconicum, and there was no other vent for it but through the aperture in the dome of the laconicum, then the more or leſs that aperture was cloſed by the ſhield, the more or leſs heat would be retained in the ſudatorium (admitting a communication); and thus the ſhield would regulate the heat, as Vitruvius expreſſes.

With regard to the ſize of the ſudatories, it was probably not great: a great height would impede their uſe, and require an unneceſſary degree of heat to warm them; particularly the lower part, where the people ſat. In the antient painting, the height to the arch appears to be about 10 or 12 feet, or twice the height of the men, which is a probable meaſure; and this is alſo about the breadth of the ſudatories in the examples that have come to our knowledge, agreeing therein with the words of Vitruvius, that the breadth and height, to the bottom of the arch, were equal.

rhetoricians, and others who delight in the ſciences, may ſit to converſe; for, in the paleſtra's, a periſtyle[1*] (D) whether ſquare or oblong, is ſo contrived, that, in the circuit of its ambulatory, it may contain two ſtadiæ[2*]. This the Greeks call *diaulon*; and herein three porticos (A B C) are formed ſingle; and a fourth (E), which is diſpoſed to the ſouth[3*], double, that the weather, when tempeſtuous, may not annoy the interior walk.

In the double portico theſe apartments are diſpoſed: The ephebeum (F), which is a vaſt exedra with ſeats, is in the middle, and is made a third part longer than broad. Upon the right is the coriceum[4*] (G), then the coniſterium (H), adjoining; and next to the coniſterium, on the returns of the portico, is the cold bath (I), which the Greeks call *loutron*. Upon the left of the ephebeum is the elæotheſium[5*] (K); adjoining the elæotheſium is the frigidarium[6*] (L); and from thence is the entrance to the propingeum[7*] (M), on the returns of the portico. Near by, but more inward, behind the place of the frigidarium, is the vaulted ſudatory (N), in length twice its breadth; which has, on the returns, the laconicum (O) on one ſide,

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(1*) Periſtyle literally ſignifies a circuit of columns; it is here to be underſtood an open area ſurrounded by a columnade.

(2*) A ſtadia is a furlong, or eighth part of a mile, containing ſix hundred and twenty-five Roman feet.

(3*) The words *ad meridianas regiones eſt converſa*, which I have rendered, *diſpoſed to the ſouth*, are ambiguous; former tranſlators have underſtood by them, that the double portico ſhould be expoſed to the ſouth; but I am of opinion that Vitruvius means it ſhould be placed on the ſouth ſide of the periſtyle, and conſequently be expoſed to the north; for Vitruvius deſcribes the frigidarium to be next to the portico; and the hot bath, ſudatory, &c. to be more inward, and behind the frigidarium; and therefore they muſt be lighted from the ſide oppoſite to the portico.

In the foregoing chapter, Vitruvius has told us that hot baths ſhould be lighted from the ſouth, or ſouth weſt, to the end, that they might be warmed by the rays of the ſun; which could not happen if this portico faced the ſouth; for the hot baths would, in that caſe, receive their light from the north. On the contrary, if the double portico is placed on the ſouth ſide of the periſtyle, then the baths, being lighted from the ſide oppoſite to the portico, will receive their light from the ſouth, agreeable to the directions of Vitruvius, and the frigidarium will very properly face the north; which, according to the interpretation of the tranſlators, would as improperly face the ſouth. It may alſo be added that the reaſon given for making this portico double (viz. to avoid the tempeſtuous weather) corroborates the ſuppoſition. The reaſon Palladius adds (viz. to avoid the heat of the ſun in ſummer time) is therefore unſuitable and void.

(4*) The commentators vary in their opinion concerning the uſe of the coriceum. Some ſuppoſe that as the ephebeum was the place of exerciſe for the youth, ſo the coriceum anſwered the ſame purpoſe for the girls, κωρυ, in Greek, ſignifying girls. Others imagine it to be the ſpheriſterium, or place where they exerciſed with the ball; and derive the name from one of the kinds of balls they uſed, which was called κωρυκος. Others again ſuppoſe the coriceum to be the ſame as the apodyterium, or undreſſing room; this latter conjecture ſeems the more probable, as the undreſſing-room was a neceſſary apartment to the baths; and it is wholly omitted, unleſs the coriceum was to anſwer that purpoſe. Alſo, the coniſterium, or apartment which contained the powder or ſand with which they rubbed their bodies, being deſcribed to be adjoining, adds ſome ſtrength to this opinion.

(5*) The eleotheſium is the room where they anointed, called by the Romans unctuarium.

(6*) This paſſage plainly diſtinguiſhes the frigidarium from the frigida lavatio, or cold bath. What diſtinct purpoſe the frigidarium anſwered can only be conjectured. Galiani thinks it anſwered the uſe of the tepidaria in the Roman baths; which was a room of a middle degree of heat, ſerving for thoſe who had uſed the ſudatory, or hot bath, to reſt in a ſhort time, in order to cool the body more gradually. To make another conjecture, it may have been the reſervatory of the cold water, from whence the baths were ſupplied; for Vitruvius has, in the preceding chapter, called the veſſel containing the cold water by the ſame name, and has aſſigned no other apartment in the paleſtræ for that indiſpenſible purpoſe.

(7*) Propnigeum is ſynonymous with hypocauſtum, or furnace.

built in the manner before written; and oppoſite the laconicum, the hot-bath (P). In the periſtyle of the paleſtræ, the parts are diſtributed as above written.

OUTWARDLY three porticos are built; one (Q), in paſſing out from the periſtyle, and, on the right and left, the two ſtadial porticos (R S); of which the one (S) that faces the north is made double, and of a great breadth; the other (R) is ſingle, and ſo deſigned, that, in the parts which encircle the walls, and which adjoin to the columns, there may be margins for paths, not leſs than ten feet; and the middle is ſo excavated, that there may be two ſteps, a ſoot and a half in deſcent, to go from the margin to the plane (R), which plane ſhould not be leſs in breadth than twelve feet; by this means, thoſe who walk about the margins in their apparel will not be incommoded by thoſe who are exerciſing themſelves. This portico is, by the Greeks, called *Xyſtos*; becauſe, in the winter ſeaſon, the athletæ exerciſe themſelves in theſe covered ſtadiæ.

THE xyſti have groves or plantations (T) between the two porticos, and walks between the trees, with ſeats of ſignine[8*] work. Adjoining to the xyſtus (R), and double portico (S), are the uncovered walks (U), which the Greeks call *peridromidas*, and we *xyſtus*; to which the athletæ, in fair weather, go, from the winter xyſtus, to exerciſe. Beyond[9*] the xyſtus is the ſtadium[10*] (W), made ſo large that the multitude of people may have ſufficient room to behold the conteſts of the athletæ. I have now deſcribed the proper diſpoſition of all buildings that are found to be neceſſary in large cities.

CHAPTER XII.

Of Ports, and of Structures built in the Water.

SOME account of ports, and the means by which ſhips may be preſerved from tempeſts, muſt not be wholly omitted. Of theſe, ſuch as are natural, and have capes, or projecting promontories, from whence there is an inward curve or return, formed naturally, are experienced

(8*) Signimus is a kind of terras. See note 1*. chap. IV. Book II.

(9*) Vitruvius has before told us that the Greeks called the covered place of exerciſe Xyſtus; and here he tells us the Romans gave that name to the uncovered walks. This double and indeterminate ſignification of that word occaſions ſuch a perplexity in the deſcription as renders it very difficult to be underſtood; we cannot be certain when Vitruvius means the covered and when the uncovered ſtadia; and this has been the reaſon that the draughts of the paleſtræ, made by the ſeveral tranſlators, are ſo very different to each other.

(10*) The ſtadium was the place allotted for the performance of the races.

to be the moſt ſerviceable; for porticos or arſenals are built around, and a road is made from the porticos to the emporium, having towers on either ſide, from whence the chains may be drawn by machines.

But if the place is not ſo formed by nature, nor is adapted to ſecure veſſels from tempeſtuous weather, this method muſt be uſed: Walls or bulwarks muſt be carried forward from one ſhore, if no river prevents it, or if the ſtream may be turned, towards the other ſhore, and, by this means the incloſure of the port muſt be formed.

These ſtructures which are built in the water are to be thus executed: The ſand[1*] of the country, which extends from Cumæ to the promontory of Minerva, is procured, and mixed with lime, in the proportion of two to one; then, in the intended place, fences of oaken piles, bound with chains, are fixed in the water, and firmly united.

When this is done, the ground at the bottom of the water, between theſe fences, is, by means of tranſtilli[2*], cleared and levelled, and rubble ſtones, with mortar, mixed in the manner before written, is thrown in, till the ſpace between the fences is quite full. The countries above mentioned have this natural advantage.

But if theſe fences ſhould not be able to reſiſt the undulation and violence of the open ſea, then, from the ſame ſhore, a ſtrong buttreſs muſt be built. Half this buttreſs is built to a level plain, and the remaining part, which is next the ſea, has an inclined ſide. This done, on the part next the ſea, and round the ſides of the buttreſs, margins of a foot and an half are built, level with the plain part before-mentioned, and on the inclined ſide; it is filled with ſand to the level of the margins and plane of the buttreſs; then on this place a pier of a ſufficient magnitude is erected; and, when finiſhed, left to dry at leaſt two months. After this, the margins which ſupport the ſand are thrown down, and the ſand being then waſhed away by the waves, the pier is precipitated into the ſea. Thus, proceeding as often as neceſſary, the work may by this means be carried forward in the ſea.

But, in countries where the pozzolona ſand is not to be obtained, the following method muſt be uſed. In the place propoſed, double fences, well bound together with planks and chains, muſt be erected, and the intervals rammed with loam and bandages[3*] made of lake weeds. When they are rammed as cloſe as poſſible, then the cochlæ, rotæ, and tympani[4*] being applied,

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(1*) This is the pozzolona ſand deſcribed at the ſixth chapter of the ſecond book.

(2*) What is meant by *tranſtili* is uncertain; but it may be ſuppoſed they were ſome kind of machines in uſe among the ancients, for the purpoſe of clearing and levelling the ground under the water. Barbaro thinks they were floats, or rafts of timber, on which the men ſtood to work.

(3*) The ſignification of the word *meronibus*, which, guided by the ſenſe of the context, I have rendered bandages, is alſo unknown.

(4*) Theſe machines are deſcribed in the ninth, eleventh, and twelfth chapters of the tenth book.

the place between the two fences is emptied and dried; and if the foundation is looſe ground, it is dug till a ſolid bottom is found, larger than the wall which is to reſt thereon. When it is thus emptied and dried, the wall is then completed with ſtones, lime, and ſand. But, if the foundation ſhould prove to be infirm, it is to be ſecured with piles of alder, olive, or oak, ſcorched, and the interſtices rammed with coal in the ſame manner as has been deſcribed for the foundations of theatres and other walls; after which the wall is raiſed of hewn ſtones, the joints being as long as poſſible, that the middle ſtones chiefly may be ſecured by the joints. Then the inner part of the wall is filled with rubble or maſonry, and thus a tower may be erected thereon.

This done, the arſenals are built ſo as principally to face the north; for the ſouthern aſpects, on account of the heat, breed and cheriſh moths, worms, and other noxious vermin. In theſe buildings very little timber is to be uſed, in order to avoid the hazard of fire. With regard to their magnitude, nothing can be determined; they muſt be made ſo as to be ſuitable to the greatneſs of the navy, and, in caſe larger fleets ſhould be brought in, that there may be ſufficient room to diſpoſe them.

Concerning the public buildings which are neceſſary for the accommodation of cities, and the manner in which they ſhould be deſigned and executed, I have, as far as they have occurred to me, treated in this volume. The ſymmetry and convenience of private buildings I ſhall explain in the following books.

THE END OF THE FIFTH BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE SIXTH.

PROEM.

ARISTIPPUS the Socratic Philoſopher, when ſhipwrecked on the coaſt of Rhodes, obſerving ſome geometrical figures there deſcribed, is ſaid to have called to his companions thus: "Rejoice! for I ſee the ſigns of men!" and immediately ſought his way to the city of Rhodes; where going directly to the Gymnaſium[1*], and diſcourſing on philoſophy, he was ſo enriched with preſents as not only to ſupply himſelf, but alſo all thoſe who accompanied him, with apparel and other neceſſaries of life. When his companions intended to return to their own country, they aſked him what he would have them ſay to their countrymen; upon which he bade them ſay that the poſſeſſions and endowments they provided for their children ought to be ſuch as would relieve them even from the diſtreſſes attending ſhipwreck; for ſuch were the true ſupports of life, which neither the adverſe blaſts of fortune, the changes of public affairs, nor the devaſtation of war, could affect. Theophraſtus alſo, enlarging on the proverb, that the learned, rather than the rich, ought to be honoured, writes thus: The learned only, either when travelling in foreign countries, or under the loſs

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(1*) Galiani here obſerves that the word Gymnaſium is no where elſe mentioned by Vitruvius; which muſt be an overſight: for it is mentioned in the laſt chap. of the firſt, and in the fifth chap. of the ſeventh Book.

of relations and neceſſaries, are in no want of friends, but are citizens in all cities, and may fearleſsly deſpiſe the accidents of fortune: but he who is ignorant, and thinks himſelf ſecured by his wealth, walks on ſlippery paths, and paſſes an uncertain and hazardous life. Epicurus in like manner ſays, the wiſe are rarely indebted to fortune, becauſe all things that are eſſentially neceſſary are within the command of the mind and underſtanding.

As many of the philoſophers have thus argued, ſo likewiſe the poets, who have written the antient Grecian dramas, have pronounced on the ſtage the ſame ſentiments in verſe; as Euchrates, Chionides, Ariſtophanes, and above all Alexis, who ſays, the Athenians deſerve particularly to be commended, becauſe, whereas the laws of the Greeks oblige all children to ſupport their parents, the Athenians confine it to thoſe only who have inſtructed their children in ſome art: for of all the gifts of fortune they may be eaſily deprived; whereas knowledge, united with the mind, never fails, but remains fixed to the utmoſt verge of life.

I therefore have great and infinite obligations to my parents, who, approving the Athenian laws, took care to have me inſtructed in an art; and that one, which cannot be well practiſed without ſome knowledge of literature and the ſciences. Having then, by the care of my parents, and the inſtruction of my preceptors, the means of acquiring knowledge, and being pleaſed with literary and philoſophical ſubjects, I ſtored my mind with theſe poſſeſſions, of which the advantage is, the never more being in want: and it is the great advantage of riches to want for nothing. But perhaps there are ſome who, judging erroneouſly, may think thoſe only are *ſkilful* who are rich: for which reaſon, many aiming only at that end, by joining aſſurance with riches, have obtained reputation. But I have not, O Cæſar, endeavoured to obtain wealth by my art, having preferred a little, with a good name, to an abundance, attended with infamy: ſmall therefore is the fame I have obtained; yet by theſe volumes I hope to be known to poſterity.

Nor is it to be wondered at that I may be to many unknown: other architects ſolicit and make intereſt to be employed; but I have learnt from authors that it is proper to be requeſted, not to requeſt, to be entruſted. Beſides, the ingenuous bluſh and are ſtruck with ſhame in aſking a favour; for the givers, not the receivers, of benefits are courted. But what can we think muſt be ſuſpected by him who is requeſted to entruſt another with the care of his property, but that the other's gain and emolument is the cauſe of the requeſt? The antients therefore committed their works to ſuch architects only as were of approved families, enquiring whether they had been well educated and were ingenuous and modeſt; judging the bold and arrogant not fit to be truſted. The artiſts themſelves alſo inſtructed none but their own children or kindred, and brought them up honeſt men, to whom things of value might be ſafely committed. When therefore I obſerve the illiterate and unſkilful pretend

to ſuch an art, who not only of architecture, but of every thing relative to fabrics, are ignorant; I cannot blame thoſe fathers of families who, confiding in their own knowledge, manage their buildings themſelves; judging that, if they muſt be committed to the unſkilful, it is better to ſpend their money according to their own pleaſure, than that of another. Hence it is, that no one attempts to practiſe at home any other art (as that of a ſhoe-maker, fuller, or others yet more eaſy), except that of architecture; becauſe many who profeſs it, are not really ſkilled in the art, but are falſely called architects.

For this reaſon I have been induced to write a treatiſe of Architecture, and the principles thereof, believing the gift will to all people be acceptable. As then in the fifth book I have written of the conſtruction of public works, in this I ſhall explain the principles and proportions of private edifices.

(*) By this paſſage we learn that the famous Vitruvius, the father of the art, and chief fountain from whence we draw our preſent knowledge of the theoretical part of architecture, was in his own time neglected, and little employed. We alſo learn that then, as in our days, perſons unfounded and ignorant in the art aſſumed the name of Architects, and have obtained more employment and encouragement than thoſe who were well ſkilled in their profeſſion. This will probably ever be the caſe. For the habits of ſtudy by which knowledge is acquired, and perhaps the turn of mind and diffidence which, as Vitruvius ſays, generally accompanies men of ſenſibility and merit, unfits them for dealing with the world; they are either aſhamed, or diſdain to make uſe of that craft, political cunning, and ſervility, which, according to the ſtate of mankind in ſome ages, are the neceſſary ſteps to ſucceſs. On the contrary, thoſe who have ſpent their time, not in their ſtudy, but in the world, habitually acquire that confidence which, notwithſtanding the diſcovery of their ignorance, naturally prevails, and as naturally produces errors and evils as the conſequences.

It appears then it muſt be very accidental if men of merit are ſucceſsful. They cannot ſeek, they muſt be ſought; and there are few men who chooſe to take that trouble, finding it eaſier to yield to the ſolicitations of thoſe who aſk, than ſearch for thoſe who deſerve. The generality indeed are not able to diſcover the deſerving. But this might be expected from men of rank and fortune, from their ſuperior education, and who owe it as a duty to their country to promote its honour and intereſt. In them therefore the neglect of merit is more cenſurable, or their being impoſed on by the ignorant, more ſhameful.

Men of knowledge however muſt generally expect to be neglected, and be content with little, and the happy tranquillity of their ſtudy; or, if they deſire wealth and employment, forſake their ſtudies, and prepare for the doom that awaits them, the troubles that ever attend a great intercourſe with the world.

CHAPTER I.

Of the Diſpoſition of Buildings, according to the different Climates, and the various Aſpects of the Heavens.

FOR theſe to be properly conſtructed, the region or climate of the world in which they are to be erected ſhould be firſt conſidered:——Egypt requires one manner, Spain another, a different one at Pontus, another at Rome; and ſo of other countries and climates, the nature of which ſhould determine the ſtyle of the building: for ſome parts of the earth are annoyed by the heat of the ſun, ſome are too far from it, while others again are of a moderate temperature. As then, by the conſtitution of the world, the inclination of the zodiac, and the courſe of the ſun, the ſeveral parts of the earth are naturally of different temperatures; ſo the diſpoſition of buildings ſhould be regulated by the nature of the climates, and the various poſitions of the heavens. Edifices in the northern parts ſhould be vaulted and incloſed; not laid open, but turned to the warm aſpects: on the contrary, in the ſouthern regions, which are oppreſſed by the intenſe heat of the ſun, they ſhould be built open and expoſed to the north and eaſt; and thus the ill effects of nature may be corrected by art. Other climates alſo may be qualified by ſimilar means, according to the poſition of the heavens with regard to the earth. But theſe muſt be determined by obſervations on the nature of the place, as well as on the members and bodies of the inhabitants: for in places where the ſun moderately ſheds his beams, the natives are of a temperate conſtitution; where it ſhines vehemently, it exudes and deſtroys the temperature of the humours; and, on the contrary, in the frigid regions, which are far diſtant from the ſouth, the humidity not being exhaled by heat, the dampneſs of the atmoſphere infuſes watery humours in the inhabitants, and cauſes them to have larger bodies and baſer voices: this is the reaſon that the northern people are of huge ſtature, white colour, have ſtraight and red hair, grey eyes, and much blood; all which are occaſioned by the abundance or moiſture and coldneſs of the air: while thoſe who live near the meridian axis (equator) under the line of the ſun, are of ſmaller ſtature, ſwarthy colour, having curled hair, black eyes, weak legs, and a ſmall portion of blood, owing to the violent heat of the ſun: having therefore but a ſmall quantity of blood, they are more timid in war, but will endure heat and fevers without fear, becauſe their bodies are nouriſhed by heat; while the people who are born in the northern climates are more fearful of, and affected by, fevers; but, being replete with blood, are undaunted in war.

Nor is there leſs difference and variety in the ſounds of the voices of different nations; for at the limits of the eaſt and weſt, near the equidiviſion of the earth, where the ſuperior

part of the world is divided from the inferior, there appears to be naturally a level circle, which the mathematicians call *horizonta:* retaining this in mind, from the edge which is in the northern region, ſuppoſe a line to be drawn to that which is in the meridian axis,[1*] from whence another oblique line is drawn up to the cardinal point (the pole) which is at the north ſtar; we ſhall then obſerve that this forms a triangular figure ſimilar to the inſtrument which the Greeks call *ſambucen.*[2*] Now as this oblique line, near its termination in the meridian axis, is but little diſtant from the baſe, the tone of voice of the people dwelling in thoſe parts, on account of the ſmall elevation of the pole, is exceedingly ſhrill and acute; as is the tone of that part of the ſtringed inſtrument which is near the angle. Thoſe who inhabit the middle part about Greece, abate in the acuteneſs of their voices. Proceeding from the middle to the extremity under the northern ſkies, the ſpeech of the people gradually becomes more and more baſe. Thus it appears that the whole world, by the due declination and temperature of the ſun, is conſtituted harmonically; and hence the people who inhabit the middle parts between the meridian axis and the northern regions have, as in the muſical ſcale, a moderate tone of voice. Advancing northward, as the pole has a greater elevation, ſo the people being fuller of moiſture have naturally baſer voices, like the ſounds of *hypatos* and *proſlambanomenos.* And for the ſame reaſon, from the middle parts towards the ſouthern nations, the voices of the people are more ſhrill, like the acute ſound of paranete.

That the voice is rendered baſer by the humid nature of a place, and more acute by its fervidity, may be thus experienced. Take two veſſels equally burnt, in the ſame furnace, of equal weight and yielding the ſame ſound: immerſe one of theſe in water, and when it is taken out, upon ſtriking both there will be perceived a great difference in their ſounds, nor will they be of the ſame weight. So it is with human bodies, although of the ſame ſhape and born under the ſame conjunctions of the planets: ſome, on account of the heat of the climate, ſpeak in an acute tone; while others, from the abundance of moiſture, utter the loweſt degrees of ſound. The clearneſs of the atmoſphere alſo, owing to the fervent heat, renders the ſouthern people quick of mind and ready in devices; but the northern nations, who breathe a groſs atmoſphere, have, on account of the cold humidity of the air, more ob-

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(1*) By meridian axis, which I have rendered literally, it is evident that Vitruvius does not mean the ſouth pole, but ſome point in the equator, for he ſpeaks of it as being under the line of the ſun. He ſeems to have an idea, that the earth extended no farther ſouthward than the equator, and that Greece was ſituated about the middle between it and the moſt northern parts; ſo that the figure he deſcribes may be conceived thus:

The circle ADB is the horizon.
A the edge in the northern region.
B that in the meridian axis, or equator.
C Media Græcia.
* the north ſtar.

(2*) Suppoſed by ſome to be a kind of harp, by others the ſyrinx or triangular ſet of reeds with which the god Pan is uſually repreſented; it is probably the former, as Vitruvius uſes the words organo chorda preſently after. At the laſt chapter of the tenth book it is again mentioned.

tuſe intellects. This may be obſerved by ſerpents, which, when the cold vapours are diſpelled by heat, move with vivacity; but at Brumalia[3*], and in winter time, by the coldneſs of the air, they become ſluggiſh and ſtupid: it is therefore no wonder that the intellects of men ſhould be rendered more acute by the warmth of the air, and more heavy by its frigidity. But although the ſouthern people have the moſt acute intellects, and are extremely ſagacious in council, yet in courage they fail, the ſun abſorbing their ſpirits; while thoſe who are born in cold climates are prompt to the ardours of war, and without fear vigorouſly make their attacks; but having dull intellects, and ruſhing on without conſideration or judgment, their attempts are eaſily defeated.

Thus by the conſtitution of nature all nations differ, according to the variations of the climate; and it has ſo happened that the people of Rome poſſeſs the middle parts and regions of the whole earth, and for that reaſon the Italians have a due mixture, both of ſtrength of body, and vigour of mind. For as the planet Jupiter, which moves between the fervid orbit of Mars, and the cold orbit of Saturn[4*], is of a due temperature: ſo the people of Italy being ſituated between the northern and ſouthern regions, and having a due mixture of both, have thoſe qualities that render them invincible; overcoming by ſagacity the force of the Barbarians, and by force the ſagacity of the ſouthern nations. The divine Mind has thus ſituated the city of the Roman people in an excellent and temperate climate, that they might poſſeſs the empire of the whole earth. Since then the ſeveral parts of the earth are, from the inclination of the heavens, of various temperatures, and the inhabitants are, by nature, accordingly varied in the qualities of their minds as well as in the figure of their bodies, we can have no doubt but that the diſtribution of buildings ſhould alſo be adapted to the qualities of the different countries and people, as it is, by Nature herſelf, wiſely and plainly indicated.

Thus I have explained, as well as I have been able, the chief rules regarding ſituations according to the nature of things, and have ſpoken of the ſuitableneſs of edifices to the different conſtitutions of the people, occaſioned by the poſition of the ſun, and declination of the heavens: I ſhall now therefore briefly treat of the ſeveral kinds of ſymmetry to be uſed in buildings, as well in the whole, as in their ſeparate parts.

(3*) Brumalia was the time of the feaſts of Bacchus, celebrated at the beginning and end of winter, one on the 15th of Auguſt, and the other on the laſt day of February.

(4*) The antient planetary ſyſtem muſt here again be recollected, which placed the Earth at reſt in the center, the Sun and the other planets moving round it in the order following: 1ſt, the Moon; 2d, Mercury; 3d, Venus; 4th, the Sun; 5th, Mars; 6th, Jupiter; and 7th, Saturn: ſo that, according to this ſyſtem, the orbit of Mars was next to that of the Sun, and therefore ſuppoſed to be in a great degree of heat.

CHAPTER II.

Of the Proportions of private Buildings.

NOTHING ought to be more the care of an Architect, than that the ſeveral parts of an edifice be in exact proportion; when therefore the kind of ſymmetry and the magnitudes are ſettled, it is then the part of the judgment to adapt them to the nature of the place, the uſe, or the ſpecies, and, by diminution or addition, to qualify the ſymmetry, till it appears rightly adjuſted, and leaves nothing defective in the appearance. For ſome objects are to be viewed near, others elevated; ſome are incloſed, others expoſed; in all which, great judgment is required to modify them ſo that at laſt the work may be perfect: for the ſight does not always inform juſtly, but often differs from the judgment; as in painted ſcenes, where columns, mutules, and ſtatues, ſeem to project and be prominent, although they are undoubtedly flat planes.[1*] The oars of ſhips likewiſe, when under water, are really ſtraight, notwithſtanding they appear to the eye to be crooked; for the inſtant before their ends touch the ſurface of the water they appear ſtraight, as they are; yet as ſoon as they are plunged into the water, by means of the tranſparent medium, their images are refracted toward the ſurface, and cauſe them to appear crooked; and whether this be owing to the impulſe of the images, or to the divergence of the rays from the eyes, whichever philoſophers will admit, we however find that either way the eyes are deceived.[2*] As then things may appear falſely, and may be different from what they ſeem to the eyes, I think it cannot be doubted, but that we ſhould diminiſh or enlarge objects according to the nature of their ſituation, in order that no part of the work may be unſatisfactory; but this muſt be effected by the acuteneſs of genius, and cannot be taught by precepts.[3*]

(1*) This paſſage affords good reaſon for believing that the antients well underſtood the art of perſpective, which ſome have doubted on account of the defective examples of it which have come to our knowledge. See alſo the Proem to the ſeventh book.

(2*) Vitruvius ſpeaks according to the philoſophy of his time in accounting for the crooked appearance of oars in the water; which is now known to be cauſed by the refraction of the rays of light paſſing through that denſer medium.

(3*) The ſubject here treated of, viz. altering the uſual proportions of objects when placed in ſome ſituations, or under ſome peculiar circumſtances, is a point much conteſted.

In firſt determining or ſelecting the proportion to be given to an object, regard muſt undoubtedly be paid to its uſe, place, or other circumſtances; but that being done, whether a deviation therefrom may on any account be proper, is the queſtion.

The only, or chief, reaſon that occurs to me for ſuch deviation, is that without it the object, when in its place,

The mode of the ſymmetry therefore being firſt fixed, the alterations are to be made thereon; then the length and breadth of the plans of the ſeveral parts of the intended work are to be determined, the magnitude of which being ſettled, the proportions are to be adjuſted according to the rules of decor,[4*] ſo that upon examination the eurithmy may not appear deficient. By what means this may be effected, it is my part to explain. And I ſhall firſt mention how cavædiums ſhould be conſtructed.

would not appear of the required proportion, or figure; and that by the alteration (ſometimes even to diſtortion) the required appearance will be obtained.

In all common ſituations, to which the eye is accuſtomed, no deviation can be requiſite, for in ſuch caſes people have acquired by habit a power of allowing for appearances, perceive the real proportions of objects, and even ſee ideally the whole of members partly hidden from their view. Indeed in no ſituation do we ever ſee the whole of an object; for the projections of ſome parts always intercept the view of others: but we have acquired the power of allowing for the interception; we can change our place, and obſerve how the change affects the appearances of the members: we can alſo uſe the ſenſe of feeling in ſome caſes; and there may be other means that unobſervedly operate in enabling us to form a juſt idea of the proportions and figure of objects in familiar ſituations; in ſuch the circle appears to us truly circular, and the ſquare truly rectangular, notwithſtanding the obliquity of the view may make the viſual angle formed by one diameter leſs than that of the other.

But in all unuſual ſituations, in which the eye is inexperienced, ſome deviation may be proper; as, for inſtance, in extraordinary heights or diſtances; in caſes of intentional deception, where the view is confined to one ſpot, or ſome particular end is aimed at; when the expreſſion of character is attempted, and where parts are required to appear larger or leſs than they are in reality, and where a variation from the uſual dimenſions of the accompanying objects may produce the effect deſired. In uncommon heights alſo, the perpendicular ſurfaces being ſo much hidden by the horizontal projectures, it may be proper to leſſen the latter as well as to increaſe the former, or to incline them forward, as Vitruvius directs in the third chapter of the third book.

Such deviations I have myſelf frequently had occaſion to practiſe, and ſee the propriety of, particularly in the chapel of Greenwich Hoſpital, where the effects often ſingularly diſappointed the expectation, and demanded the deviations mentioned.

In theſe and ſuch adjuſtments no rules or precepts (as Vitruvius well obſerves) can avail: natural power of mind, improved by obſervation and practice, can alone ſucceed; and in this chiefly taſte, or the perception of beauty, propriety, and character, will be evident in the compoſer.

(4*) For the explanation of decor, ſee Book I. Chap. II.

CHAPTER III.

Of Cavædiums.

THERE are five diſtinct kinds of cavædiums,[1*] which from their forms are named thus, Tuſcan, Corinthian, Tetraſtyle, Diſpluviated, and Teſtudinated.

Fig. LIII. The Tuſcan kind are thoſe in which the beams (a a) that croſs the breadth of the atrium, have interpenſivæ[2*] (b b); and gutters (c c) proceeding from the angles of the walls to the angles of the joiſts; alſo from the aſſers (e) the eaves water is diſcharged into the middle compluvium[3*] (d d).

(1*) The term cavædium is derived from the words cava-ædium, and means courts or other void ſpaces within the body of a houſe.

(2*) Perrault has repreſented the interpenſivæ as diagonal props or braces, their lower ends reſting in the wall, and their upper ends ſupporting the eaves projected forward: but this is not reconcileable to the words of the text, in the deſcription of the tetraſtyle cavædium; "utilitatem trabibus & firmitatem præſtant, quod neque "ipſæ magnum impetum coguntur habere, neque ab "interpenſivis onerantur;" which imply that the interpenſivæ were things ſupported, not ſupports; and alſo that they were not ſituated under the beams, but reſted upon them. Perrault would interpolate the text in order to make it bear his conſtruction, by adding *parietibus* after *trabibus*, and thus transferring the alluſion of the paſſage from the beams to the walls.

Galiani is of opinion that the interpenſivæ were two beams that laid lengthways of the cavædium over the two beams that laid breadthways; and has tranſlated the text accordingly. But as in ſuch a caſe the beams on two ſides of the cavædium would lie higher than thoſe on the other two ſides, the columns that ſupported thoſe beams in the Corinthian cavædiums (which are deſcribed to be the ſame as the Tuſcan, with only the addition of columns around) would alſo be of different heights; which is an irregularity ſo unuſual that it cannot be admitted. Beſides, Vitruvius has in other places deſcribed the beams by the term *trabes*, and it is not likely that in this place only he ſhould have called them interpenſivæ.

Philander ſuppoſes the interpenſivæ to be the joiſts or timbers (b b) that were laid from the wall to the beams (a a) Fig. LIII. and LIV. which is alſo my opinion, excepting that I believe the word was confined in its application to thoſe caſes where the ſaid joiſts projected beyond the beams, forming what we now call conſoles, or cantilivers, as in the Tuſcan order according to the deſcription of Vitruvius. But Perrault alleges, in oppoſition to the opinion of Philander, that the interpenſivæ are deſcribed to proceed from the angles of the walls to the angles of the joiſts (tignæ): that I think is not the caſe, as the words of the text may, and I believe do, allude to the gutters (*colliquias*), and not to the interpenſivæ.

Perrault alſo differs from all the other tranſlators in his acceptation of the word *colliquias*, which he has rendered *the coyers*, i. e. the rafters that are placed at the angles of roofs; but it is highly probable that it ſignifies ſome kind of gutters or channels, as it is generally underſtood. Columella, 2. 8. uſes it in that ſenſe, and Pliny, 18. 19. writes collicias (as it is alſo written in ſome manuſcripts of Vitruvius) in the ſame ſignification.

(3*) Barbaro and Galiani ſuppoſe the compluvium to be a reſervoir made in the middle of the pavement of the cavædium, but in the diſpluviated cavædium it is ſaid the compluviums being erect intercept not the light from the apartments. Which words forbid ſuch a ſuppoſition, and ſhew that the compluvium muſt be above the windows. Perrault judges it to be the gutter (d d) at the eaves where the rain water from the whole roof is collected; and this opinion ſeems to me to be juſt, and is

Fig. LVII. and LVIII. In the Corinthian cavædium, the beams and compluvium are diſpoſed in the ſame manner; but as the beams project from the walls, columns are arranged in the circuit around.

Fig. LIV. The tetraſtyle are thoſe wherein columns (g g) are placed under the beams at the angles, giving ſtrength and ſupport to thoſe beams; for by this means they are neither ſtrained by their own great length, nor are they depreſſed by the interpenſivæ.

Fig. LV. The diſpluviated are ſuch in which the eaves that ſupport the incloſure of the gutters (deliquiæ[4*]) return backward: theſe are chiefly uſeful in winter apartments, becauſe their compluviums (a a) being erect, intercept not the light from the rooms; but they have great inconveniences with regard to reparation, for the pipes (b b) that receive the water flowing from the eaves, being againſt the walls, and not receiving quickly enough the deſcending water from the gutters, it overflows and damages the internal work and walls in theſe kind of buildings.

Fig. LVI. The teſtudinated are made where the ſpan (impetus) is not very great; and ſpacious apartments are erected in the floors above them.

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corroborated by the following paſſage in Varro, book the 4th. "In cavædio ſi locus nullus relictus erat ſub divo "qui eſſet, dicebatur teſtudo: ſi relictus erat in medio "ut lucem caperet deorſum qua impluebat, impluvium "dictum—& ſurſum qua confluebat, compluvium."—"In "the cavædium, if no part be left uncovered, it is called "teſtudo; if left uncovered in the middle to admit the "light, the place through which the rain falls is called im-"pluvium; and above where it flows together is called "compluvium." From the compluvium (d d) the water muſt have been diſcharged through the ſpouts uſually formed in the ſima of the cornice in the ſhape of lions' heads, and either retained in a reſervoir made in the middle of the cavædium, or carried off by drains. But in the diſpluviated cavædiums the compluvium, which is ſaid to be erect, may have been placed on the top of the wall and behind the parapet; the water being brought down by perpendicular pipes fixed within or againſt the face of the wall, as is our preſent practice.

(4*) The tranſlators in general (led probably by the comment of Philander) have underſtood the word *deliquiæ* in this place to ſignify ſome timbers of the roof or eaves, as Perrault has underſtood *colliquias*. But I cannot help being of opinion that both theſe words ſignify ſome kind of gutters, and that even from the very paſſage that Philander quotes from Sext. Pompeius. This author uſes the words *collitias* and *delitias* in the ſame ſenſe, and ſays the *collitias tegulas* were a kind of tiles by which water was conveyed into veſſels; they therefore muſt have been a ſort of gutter-tiles to anſwer that end: and this evidently ſhews the ſignification of the word *collitia*, and conſequently of *deliquia*.

CHAPTER IV.

Of the Atrium, Alæ, Tablinum and Periſtylium, with their Dimenſions and Symmetry.

THE length and breadth of atriums[1*] are regulated in three manners: the firſt is, when the length being divided into five parts, three parts are given to the breadth; the other is, when divided into three parts, two parts are allowed to the breadth; and the third is, when a ſquare of equal ſides being formed on the breadth, and in that ſquare a diagonal line drawn, the length of the atrium is made equal to that diagonal line; their height, to the

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(1*) Whether Vitruvius means the ſame place by the words *atrium* and *cavædium* is a point that has never yet been decided. Perrault believes them to be different apartments, Galiani aſſerts they are one and the ſame, and Barbaro and Palladio are of the latter opinion.

Perrault alleges that atriums are deſcribed by Vitruvius to have alæ on the right and left, which has no ſimilarity to any one of the five ſorts of cavædiums he deſcribes.

Galiani founds his opinion on Vitruvius uſing the word *atrium* in deſcribing the Tuſcan *cavædium*, and his omitting to give the proportions of cavædiums till he treats of them in this chapter under the name of atriums, alſo on his mentioning in one paſſage at chap 8. *veſtibula, cavæ-ædium, periſtylia*; and again in another paſſage, *veſtibula regalia, alta atria, & periſtylia*; in which paſſages, *cavædium* in one, has the ſame place as *atria* has in the other: Vitruvius alſo, he alleges, begins the chapter on atriums as if it were the continuation of the ſubject he had been treating of in the foregoing chapter: Atriorum vero longitudines, &c.

This ſubject ſeems not ſufficiently explained by Vitruvius to admit of a ſatisfactory deciſion. I ſhall however mention ſuch obſervations as have occurred to me thereon. Cavædiums, as their name imports, were covered or open areas, within the body of the houſe, from which (when open) the apartments around received their light, as Vitruvius intimates in the deſcription of the diſpluviated cavædium. Whereas atriums were always placed near the gate, as mentioned at the 8th chapter following. Atriums are alſo deſcribed, as Perrault obſerves, with alæ on the right and left ſides only, but cavædiums are ſaid to be ſometimes without columns, and conſequently without alæ; ſometimes with columns, and alæ of courſe, all around, and ſometimes with columns only at the four angles; nor are any deſcribed of a form that can be ſaid to have alæ on the two ſides only. The alæ of atriums are deſcribed to be no higher than they are broad; but the alæ of cavædiums, by their conſtruction, muſt have two, three, or four times their breadth in height. Atriums had an aperture in the ceiling of an aſſigned proportion to give light; but of cavædiums, ſome are deſcribed to be entirely covered, and ſome wholly uncovered. The forms of cavædiums that have columns will not agree with the proportions of atriums, as here given, as will be noticed hereafter, without rendering them incommodious and ſcarcely paſſable. Laſtly, Pliny in the deſcription of his villa at Laurentinum mentions its having both an atrium and cavædium: "In prima "parte *atrium* frugi, nec tamen ſordidum, deinde porticus "in O literæ ſimilitudinem circumactæ,.....eſt contra me- "dias *cavædium* hilare;" which is a ſtrong evidence that theſe terms ſignified different places.

The reaſon that Vitruvius does not ſpeak of the proportions of cavædiums may be becauſe they had no fixed proportion, being governed entirely by the diſtribution of the apartments of the houſe, and were longer or ſhorter, larger or ſmaller, juſt as thoſe apartments required.

Perrault has made a miſtake in his plan P. LIII. having placed the cavædium near the entrance, and the atrium behind within the body of the houſe, which is directly contrary to the deſcription.

under ſide of the beams, is as much as their length, wanting a fourth part: the remainder[2*] is given to the lacunaria and arcæ above the beams.

The breadth of the alæ on the right and left, if the length of the atrium be from thirty to forty feet, is made a third part thereof: if the length be from forty to fifty feet, it is divided into three parts and a half, of which one part is given to the alæ; if the length be from fifty to ſixty feet, the alæ have a fourth part of the length; if from ſixty to eighty, the length is divided into four parts and a half, of which one part makes the breadth of the alæ; if from eighty to a hundred feet, the fifth part of the length exactly conſtitutes the breadth of the alæ: their lintel beams are placed ſo high that the heights may be equal to the breadths.[3*]

(2*) What is to be underſtood by the word *reliquum* is a little doubtful: by the ſentence preceding it ſeems moſt naturally to point to the remainder of the length of the atrium when three fourths is deducted therefrom; and yet one fourth of the length of the atrium ſeems to be too great an allowance for the lacunariæ and arcæ, if by thoſe words the entablature be underſtood.

The lacunaria very probably means the entablature, but the arcæ, which in the foregoing chapter is mentioned in ſpeaking of the gutters, and generally ſignifies ſome kind of fence, may very likely allude to a plutæum or fence (like our baluſtrades or parapets) on the top of the cornice; on this ſuppoſition, one fourth of the length may be a very reconcileable proportion.

Galiani ſuppoſes that as Vitruvius hereafter preſcribes (as a general rule for all apartments) that their height ſhould be equal to half the united ſum of their length and breadth, the word *reliquum* alludes to the remainder of that proportional height when three fourths of the length of the atrium is deducted therefrom; but then he has underſtood the words *lacunariorum & arcæ* to mean the parts between the tops of the columns, and the ceiling of the alæ: which idea the following note will contribute to diſprove.

(3*) Vitruvius does not explain whether the breadth allowed to the alæ is to be given to each, or divided between both, nor whether the alæ were included or excluded from the proportional meaſure of the atrium before aſſigned. Both which, as well as the ſentence concerning the height of the lintel beams of the alæ, have been differently underſtood by the commentators.

Barbaro and Palladio have believed that the proportion allowed to the alæ ſhould be divided between both, and that the alæ ſhould be excluded from the beforementioned proportion of the atrium. Perrault and Galiani have agreed with them in the former, but differed in the latter point, underſtanding that the alæ are to be included in the proportional meaſure of the atrium. Barbaro indeed ſeems to have been in doubt concerning the former point, having made dotted lines to ſhew that the whole meaſure allowed might be given to the breadth of each alæ. Theſe points will be determined by the following queſtion concerning the height of the lintel beams.

"Trabes earum liminares ita alte ponantur ut altitu-
"dines latitudinibus ſint æquales." "Their lintel beams
"are placed ſo high, that the heights may be equal to the
"breadths." Theſe words ſeem to allude to the height of the lintel beams of the alæ, of whoſe proportions Vitruvius is here treating, and the breadth here mentioned ſeems alſo to mean the breadth of the alæ (making, according to his uſual method, the height and breadth equal); for in ſpeaking of the atrium before, and of the tablinum afterwards, he gives their reſpective heights at the places where he treats of their other proportions; and thoſe heights are proportioned to their own meaſures, either of length or breadth: it therefore appears moſt probable that Vitruvius follows the ſame method in treating of the alæ, and that conſequently the heights and breadths here mentioned allude to the alæ only: yet this has been otherwiſe underſtood. Barbaro and Palladio underſtand the height here mentioned to be that of the alæ, but conceive the breadth to mean that of the whole atrium; and to reconcile this with the height before allowed to the atrium, they imagine the one to mean the height to the under part of the beams or entablature, and the other to the upper part; although

it is clearly expreſſed, that the under part is meant in both caſes. This is more extraordinary in them, who conceive the atrium to be the ſame as the cavædium, where the columns are expreſsly ſaid to be placed under the beams; plainly indicating that, by the beams, Vitruvius means thoſe timbers which lie immediately over the heads of the columns.

Galiani agrees with Barbaro and Palladio in underſtanding the breadth mentioned, to mean that of the whole atrium; but he ſuppoſes the height alſo to mean that of the atrium, and not, as they do, of the alæ; although the height of the atrium has been before aſcertained: and to reconcile this with the height before allowed to the atrium, he underſtands this latter to allude only to atriums of eighty feet long and upward, becauſe that is the length mentioned by Vitruvius immediately before he ſpeaks of this latter height. But this is far from being ſatisfactory; it might with equal reaſon be ſuppoſed that where the height of the tablinum or atrium is mentioned, it alludes only to tablinums or atriums of the dimenſions immediately preceding; the words ſo interpreted occur in deſcribing the alæ, they are *trabes earum liminares, their lintel beams*; theſe muſt mean the lintel beams of the things in deſcription (i. e. the alæ), and cannot mean thoſe of the atrium, becauſe *earum* being plural ſignifies the lintel beams of two or more things. There is the ſame reaſon alſo, for ſuppoſing the word *latitudinibus* alludes to the breadth of the alæ, for it ſhould have been in the ſingular, if it had meant that of the atrium; and it would have been more like Vitruvius's manner to have added the word *atrii* after it, as he does in deſcribing the tablinum, and farther on in ſpeaking of the impluvium: *Impluvii lumen latum latitudinis atrii.* Indeed it would have been neceſſary ſo to have done, to ſhew that he did not ſpeak of the thing under deſcription; and the omiſſion of it is a ſtrong implication that it does not mean the breadth of the atrium, or of any thing but the ſubject in deſcription, viz. the alæ.

If theſe arguments be admitted to be juſt, then the other doubtful points will be hereby determined; for if the height of the alæ be no more than equal to their own breadth, it will neceſſarily follow, that the proportion aſſigned muſt be given to the breadth of each alæ, and muſt not be divided between the two, for if it were, the height of the alæ in ſmall atriums would be but five feet, which cannot be ſuppoſed.

If then each ala has in breadth the proportion aſſigned, they muſt be excluded from the proportional meaſure before given to the atrium; for ſhould they be included, they would occupy almoſt the whole breadth of the atrium, and meet in the middle. Even upon the ſuppoſition that the breadth aſſigned were divided between the two alæ, they would occupy ſo much of the atrium as to leave but a narrow ſpace in the middle, and that directly under the lumen or opening in the roof; or if to make the ſpace in the middle larger, the columns were placed within the ſpace allowed to the alæ, thoſe columns being proportioned according to their great height, would occupy ſo much of the breadth of the alæ as to leave but a very narrow and incommodious paſſage between them and the wall; as may be found upon trial of a plan according to the proportions mentioned. In either caſe the columns would engroſs ſo much as to render the apartment very unlike the idea authors give of the atrium; a ſpacious hall where great numbers of people ſometimes aſſembled, and where the buſineſs of juſtice and the ſtate was oftentimes tranſacted.

The example given by Galiani in his plate XXII. is not drawn according to the proportions preſcribed, particularly in the heights.

Barbaro alſo has not obſerved the proportions; as for Perrault's examples, being in perſpective, their proportions cannot eaſily be judged of.

It is certainly difficult to conceive any form for the atrium that will agree with the deſcription, the implication of the context, and the ſtyle of the antique architecture: if the height of the alæ be no more than equal to their own breadth, their height muſt be much leſs than that of the atrium, the latter being three fourths of the atrium's length, and the former only a third, fourth, or fifth of the ſame; ſo that if the alæ were ſeparated from the atrium by a range of columns ſupporting the beams of the atrium, the queſtion ariſes, how the part between the beams of the alæ and thoſe of the atrium was finiſhed? It could not be left open to the air, becauſe the opening for air and light is deſcribed to be in the ceiling of the atrium, and a double floor in the alæ is neither mentioned nor implied by the text; alſo how the beams of the alæ, on the ſide next the atrium, were ſupported, is not aſcertained; for there are no paraſtæ mentioned, as in the Baſilica of Fano, deſcribed in the fifth book: it cannot be ſuppoſed that their ends laid in the columns, for that would be contrary to the practice of the antients; nor can the idea of having columns no higher than the beams of the alæ ſupporting a ſolid wall from thence to the top of the atrium be approved.

From the foregoing arguments it ſeems that the atrium muſt be of a very different form to that uſually repreſented; the whole was probably one large apartment, undivided by columns, and the alæ entirely without it; but whether ſeparated therefrom by a wall, or open by columns or arches, or how connected with the atrium, we are left entirely uninformed.

That columns were ſometimes uſed in atriums, although we know not how or in what part they were diſpoſed, we may learn from the words of Pliny, book 36, chap. 2,

If the breadth of the atrium be twenty feet, deducting a third part, the remainder is given to the ſpace of the tablinum[4*]: if from thirty to forty feet, half the breadth of the atrium is allowed to the tablinum: if from forty to ſixty, the breadth is divided into five parts, and two parts are given to the tablinum; for in ſmaller atriums the ſymmetry muſt not be the ſame as in larger: ſhould the ſymmetry of the greater be uſed in the leſſer, neither the tablinum nor the alæ could be convenient; and if that of the leſſer were uſed in the greater, the members would be huge and enormous. Wherefore I have thought it proper to deſcribe exactly their reſpective proportions, regarding both their utility and appearance.

The height of the beams of the tablinum is an eighth part more than the breadth; to its lacunariæ, it is a third part of the breadth added to that height. The fauces[5*], in leſſer atriums, are a third part, in greater, a half leſs than the breadth of the tablinum: the height that the images, with their ornaments, are to be placed, muſt be according to the breadth of the alæ.

Concerning the proportion of the breadth to the height of the portals, if Doric, they

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where, after ſaying 360 columns had been brought to Rome by M. Scaurus, the edile, for the ſcene of a temporary theatre, he adds, "etiamne tacuerunt maximas earum, "atque adeo duodequadragenum pedum Lucullei marmoris, in atrio Scauri collocari"—"the largeſt of them, "thirty-eight feet long, of Luculleian marble, were "placed in the atrium of Scaurus:" and chap. 3d, after expreſſing his opinion that the ſucceeding age will diſapprove of ſuch luxury, he ſays, "quis enim tantarum hodie "columnarum atrium habet?"—"for who at this day "has an atrium with ſuch columns?" At the 1ſt chap. of the 17th book, ſpeaking of L. Craſſus, Pliny adds, "columnas quatuor Hymetti marmoris, ædilitatis gratia "ad ſcenam ornandum advectus, in atrio ejus domus ſta-"tuerat, cum in publico nondum eſſent ullæ marmoreæ; "tam recens eſt opulentia"—"four columns of Hymet-"tian marble, which he brought when edile to adorn a "ſcene, he fixed in the atrium of his houſe, at a time "when marble ones had never before been uſed in public; "ſo recent is luxury:" and at the 3d chapter of the 36th book, he ſays, "theſe columns were each but twelve "feet long." Theſe quotations, although they do not inform us how or in what manner columns were introduced in atriums, yet ſufficiently prove, that it could not be in the manner hitherto generally ſuppoſed, i. e. arranged on each ſide, and being as high as the beams of the atrium; for the ſmalleſt atrium Vitruvius deſcribes is not ſo low as twelve feet, and the largeſt is much higher than thirty-eight feet, which was the height of the greateſt columns that ever had been uſed in any private atrium at Pliny's time. Indeed the atriums of Scaurus and Craſſus, we muſt underſtand, were built before the columns were placed therein, ſo that the columns could not be uſed to ſupport the beams of the atriums on each ſide the lumen, as generally repreſented. It is therefore moſt probable that the columns of atriums, when any were introduced, were diſpoſed variouſly according as circumſtances would admit or might require, or as the genius of the architect might ſuggeſt. I have accordingly made uſe of ſuch liberty myſelf in the examples Fig. LVII. and LVIII.

(4*) The tablinum is thought to have been a place appropriated for the preſervation of the family records. Pliny, l. 35. c. 2. ſays, "tablina codicibus implebantur & "monumentis rerum in magiſtratu geſtarum." We are not told whether it be the breadth or length of the tablinum which is here ſpoken of; it is generally underſtood to be the breadth, and the following words, "altitudo "tablini ad trabem adjecta latitudinis octava conſtitua-"tur, &c."—"the height to the beams of the tablinum "is an eighth part more than the breadth," where the breadth only of the tablinum is referred to, tend to corroborate that opinion.

(5*) The fauces are ſuppoſed to be the aperture or door-way between the atrium and tablinum. See Fig. LVII.

are formed in the Doric mode, if Ionic, in the Ionic mode, as explained in the deſcription of portals in the fourth book. The breadth of the light of the impluvium[6*] is left not leſs than the fourth, nor more than the third part of the breadth of the atrium; the length is ſuch as the proportion of the atrium may occaſion.

The periſtylium[7*] is, tranſverſely, a third part longer than it is inwardly: the columns are as high as the porticus is broad; the intercolumns of the periſtyle are not leſs than three, nor more than four times the thickneſs of the columns: but if the columns of the periſtyle ſhall be in the Doric mode, modules muſt be uſed, as mentioned in the deſcription of the Doric mode at the fourth book, that by thoſe modules the diſtribution of the triglyphs may be properly adjuſted.

CHAPTER V.

Of the Triclinium, Œcus, Exedra, and Pinacotheca.

WHATEVER the breadth of a triclinium[1*] may be, twice ſo much ſhould be the length. The height of all rooms that are oblong ſhould be thus regulated: the meaſures of the length and breadth are to be united, and the half of that ſum, whatever it may be, is to be

(6*) The impluvium, from this paſſage, and from the words of Varro (quoted in the 3d note of chap. 3, of this book), we may conclude was the opening in the ceiling or roof of the atrium, through which the light was admitted. Nardini, page 136, and ſome other authors, have ſuppoſed it was the court-yard itſelf.

(7*) The periſtylium was a large area ſurrounded by a columnade, as we learn from the 11th chap. of the 5th book. Galiani adds, that the maſter's apartments were diſpoſed around it; and he has in his plan ſo diſpoſed them: but in the third chapter foregoing it is ſaid that the tricliniums (which were the maſter's apartments) received their light from the cavædium, and conſequently they muſt ſometimes at leaſt have been diſpoſed around the cavædium.

(1*) The triclinium or triclinia (as at the 8th chap. following) was the dining room; the word is ſometimes uſed for the dining table, and ſurrounding couches on which they lay to eat (ſee chap. 6). The term is ſaid to have ariſen from there being uſually three couches on the three ſides of the table, the fourth ſide being left for the attendance of the ſervants.

given to the height. But when exedræ or œci[2*] are ſquare, once and half their breadth determines their height. The pinacotheca[3*] as well as the exedra ſhould be made of an ample magnitude; the Corinthian œcus, the tetraſtyle, and thoſe which are called Ægyptian[4*], have, with regard to their length and breadth, the ſame ſymmetry as the triclinium above mentioned, but on account of the introduction of columns, they are built more ſpacious. Between the Corinthian and Ægyptian there is this difference; the Corinthian have columns placed either on the podium or on the floor, and above have an epiſtylium and cornice, either of inſide work (wood) or plaſter; alſo above the cornice is a curved ceiling formed elliptically, but in the Ægyptian, upon the epiſtylium of the columns, and from the epiſtylium to the walls which are around, is laid an unſheltered floor which is boarded and paved, and ſurrounds the whole; then upon the epiſtylium, and perpendicularly over the inferior columns, other columns, a fourth part leſs than the former, are diſpoſed, upon which is an epiſtylium and cornice, enriched with lacunariæ; and between theſe upper columns windows are placed, ſo that they reſemble baſilicas more than Corinthian tricliniums.

(2*) The exedræ, from what Vitruvius ſays of them in the 11th chapter of the 5th book, ſeem to be rooms for converſation or diſputation, and were ſurrounded with ſeats; ſome think they were apartments for ſtudy, others, for ſleeping in at noon, during the heat of ſummer. In the 9th chapter of the 7th book they are mentioned as being open places like periſtyliums, and perhaps in ſome caſes were ſo, having a range of columns on one ſide, by which they were ſeparated from the area.

The œci are explained by Vitruvius in this and in the 6th and 10th chapters following.

(3*) Picture rooms.

(4*) Barbaro believes that the Corinthian and tetraſtyle œci were the ſame, and Galiani thinks the tetraſtyle and Egyptian were the ſame. Vitruvius mentions them thus: œci Corinthii vocantur, &c. Perrault ſuppoſes all the œci to have been diſtinct apartments, which is alſo my opinion; for although the words above quoted will bear one interpretation as well as the other, yet we may draw ſome arguments from the context, that may help to decide the queſtion.

The tetraſtyle œci we may, from the import of the word, conclude had but four columns; but the Corinthian as well as the Egyptian muſt have had a range of columns around; for it is ſaid, the Egyptian were more like baſilicas than tricliniums; and that the difference between the Egyptian and Corinthian œcus conſiſted only in the former having a double order of columns, and the other but one ſingle order.

Vitruvius does not mention the difference between either of them and the tetraſtyle, becauſe it may be ſuppoſed he thought it not likely to be miſtaken, the very name of it determining the conſtruction of it, ſo far as to ſignify it had but four columns. The tetraſtyle and Corinthian cavædiums are alſo diſtinguiſhed from each other by this difference in the third chapter foregoing.

From the words, "ſed propter columnarum interpoſitiones"—"but on account of the introduction of columns," we may conclude that in common tricliniums columns were not introduced.

CHAPTER VI.

Of the Greek Œcus.

Fig. LVII. and LVIII. THERE are ſome œci not made in the Italian manner; theſe the Greeks call *cyzicenous*. They are ſituated toward the north, generally have a view of the garden, and have valved doors in the middle. They are of ſuch a length and breadth that two triclinia[1*], with their ſurrounding appendages, may be placed oppoſite to each other; they have alſo valved windows on the right and left, that the garden may be ſeen through the ſpace of the windows; their height is equal to once and a half their breadth.

In all theſe kinds of apartments ſuch ſymmetry is to be uſed as may render them convenient; and if not obſcured by high walls, they may eaſily be made light; but if they be incommoded by narrowneſs, or other impediments, then ingenuity and judgment will be requiſite to make ſuch deductions from, and additions to, the ſymmetry, as will produce a pleaſing effect, not diſtinguiſhable from that of the true ſymmetry.

CHAPTER VII.

Of the Aſpects to which theſe Kinds of Buildings ſhould be diſpoſed, to render them convenient and healthy.

WE muſt now ſpeak of the poſition of theſe kinds of buildings with regard to their uſe, and the proper points of the heavens to which they ſhould be directed. The winter triclinium and bath ſhould look to the winter weſt, becauſe the afternoon light is there

(1*) Triclinia is here uſed for the dining tables, &c.

useful[1*]; besides that the opposite western sun shining thereon produces heat, and makes that aspect warm in the evening time.

Bed-chambers and libraries should look to the east, for in these the morning light is required; it is also proper, that the books in libraries may not decay, for in those that look to the south and west, they will be damaged by the damps and worms, which the humid winds generate and nourish, infusing a moist vapour that moulds and rots the books.

The spring and autumn triclinium should look to the east; for the windows being then turned from the force of the sun proceeding westward, render those places temperate at the time they are generally used. The summer triclinium should look to the north, because this aspect is not, like the others, rendered hot at the summer solstice; for, being turned from the course of the sun, it remains always cool, and, when used, is salubrious and pleasant. To the same aspect also should be disposed pinacothecæ, as well as embroidering and painting rooms, that the colours used in the works, on account of the equability of the light, may remain unchanged.

CHAPTER VIII.

Of the private and public Apartments of Houses, and of their Construction according to the different Ranks of People.

THESE buildings being disposed to the proper aspects of the heavens, then the distribution of such places in private houses as are appropriated to the use of the master of the house, and those which are common for strangers, must be also considered: for into those that are thus appropriated, no one can enter unless invited; such as the cubiculum, the triclinium, the bath, and others of similar use. The common are those which the people unasked may legally enter; such are the vestibulum, cavædium, peristylium, and

(1*) It was the custom of the antients to make their principal meal toward the decline of day, immediately before which they usually bathed.

thoſe that may anſwer the ſame purpoſes: but to perſons of the common rank, the magnificent veſtibulum, tablinum, or atrium, are not neceſſary, becauſe ſuch perſons pay their court to thoſe who are courted by others.[1*]

People who deal in the produce of the country muſt have ſtalls and ſhops in their veſtibules, and cryptæ, horreæ, and apothecæ,[2*] in their houſes, which ſhould be conſtructed in ſuch a manner as may beſt preſerve their goods, rather than be elegant. The houſes of bankers and public officers ſhould be more commodious and handſome, and made ſecure from robbers; thoſe of advocates and the learned, elegant and ſpacious, for the reception of company; but thoſe of the nobles, who bear the honours of magiſtracy, and decide the affairs of the citizens, ſhould have a princely veſtibulum, lofty atrium, and ample periſtylium, with groves and extenſive ambulatories, erected in a majeſtic ſtyle; beſides libraries, pinacothecas, and baſilicas, decorated in a manner ſimilar to the magnificence of public buildings; for in theſe places, both public affairs, and private cauſes, are oftentimes determined. Houſes therefore being thus adapted to the various degrees of people, according to the rules of decor, explained in the firſt book, will not be liable to cenſure, and will be convenient and ſuitable to all purpoſes. Theſe rules alſo are applicable, not only to city houſes, but likewiſe to thoſe of the country; except that in thoſe of the city the atrium is uſually near the gate, whereas in the country pſeudo-urbana,[3*] the periſtylium is the firſt, and then the atrium; having a paved porticus around, looking to the paleſtra and ambulatories.

Fig. LVII. and LVIII.

I have, as well as I have been able, briefly written the rules relative to city houſes, as I propoſed. I ſhall now treat of thoſe in the country, how they may be made convenient, and in what manner they ſhould be diſpoſed.

(1*) "Quod hi aliis officia præſtant ambiundo quæ ab "aliis ambiuntur."

This paſſage is allowed to be unintelligibly worded; I have given what ſeems to me to be the ſenſe of it.

(2*) I have here written the Latin names, becauſe they are uſed in various ſenſes, and are differently rendered by the moderns; cryptæ very likely here ſignifies vaults; horreæ, repoſitories for grain, or wine, &c.; and apothecæ, ſtore-rooms for various purpoſes.

(3*) See the explanation of pſeudo-urbana at note 14, chap. 2, book 1, where it is called urbana only, pſeudo (falſe) being here added, becauſe the part of the villa that was ſo called was an imitation of a city houſe, alluded to by the word urbana; and for that reaſon it was ſometimes called pſeudo-urbana. See Fig. LIX.

CHAPTER IX.

Of Country Houſes, with the Deſcription and Uſe of their ſeveral Parts.

IN the firſt place the country ſhould be examined with regard to its ſalubrity, as written in the firſt book concerning the founding of a city; for in like manner villas are to be eſtabliſhed. Their magnitude muſt be according to the quantity of land and its produce. The courts and their ſize muſt be determined by the number of cattle and yokes of oxen to be there employed. In the warmeſt part of the court the kitchen is to be ſituated, and adjoining thereto the ox-houſe, with the ſtalls turned toward the fire and the eaſtern ſky; for the cattle ſeeing the light and fire, are thereby rendered ſmooth-coated: even huſbandmen, although ignorant of the nature of aſpects, think that cattle ſhould look to no other part of the heavens than to that where the ſun riſes. The breadth of the ox-houſe ſhould not be leſs than ten feet, nor more than fifteen; the length ſhould be ſo much as to allow no leſs than ſeventeen feet to each yoke.

Fig. LIX.

Fig. LX.

The bath alſo is to be adjoined to the kitchen, for thus the place of bathing will not be far from thoſe of the huſbandry occupations. The preſs-room ſhould be near the kitchen, that it might be convenient for the olive buſineſs; and adjoining thereto the wine-cellar, having windows to the north; for, ſhould they be toward any part which may be heated by the ſun, the wine in that cellar would be diſturbed by the heat, and become vapid. The oil-room is to be ſo ſituated as to have its light from the ſouthern and hot aſpects; for oil ought not to be congealed, but be attenuated by a gentle heat. The dimenſions of theſe rooms are to be regulated by the quantity of fruit, and the number of the veſſels; which, if they be cullearıæ[1*], ſhould in the middle occupy four feet. Alſo, if the preſs be not worked by ſcrews, but by levers, the preſs-room ſhould not be leſs than forty feet long, that the preſſers may have ſufficient ſpace: the breadth ſhould not be leſs than ſixteen feet, by which means there will be free room to turn, and to diſpatch the work: but if there are two preſſes in the place, it ought to be twenty-four feet broad. The ſheep and goat houſes are made ſo large, that not leſs than four feet and a half, nor more than ſix feet, may be allowed to each animal.

(1*) A veſſel containing 108 gallons, or, according to ſome, 143 gallons and 3 pints.

The granary ſhould be elevated from the ground, and look to the north or eaſt, for thus the grain will not ſo ſoon be heated, but, being cooled by the air, will endure the longer: the other aſpects generate worms and ſuch vermin as uſually deſtroy the grain.

The ſtable, above all in the villa, ſhould be built in the warmeſt place, and not look toward the fire, for if theſe cattle be ſtalled near the fire, they become rough-coated; nor are thoſe ſtalls unuſeful which are placed out of the kitchen,[2*] in the open air, toward the eaſt; for in the winter time, when the weather is ſerene, the beaſts, being led thither in the morning, may be cleaned while they are taking their food.

The barn, hay-room, meal-room, and mill, are placed without the villa, that it may be more ſecure from the danger of fire.

If the villa is to be built more elegantly, it muſt be conſtructed according to the ſymmetry of city houſes, before deſcribed; but ſo as not to impede its uſe as a villa.

Great care ought to be taken, that all buildings have ſufficient light, which in villas is eaſily obtained; becauſe there are no walls near to obſtruct it. But in the city, either the height of the party-walls,[3*] or the narrowneſs of the ſtreets, may occaſion obſcurity. It may however be thus tried; on the ſide where the light is to be received, let a line be extended from the top of the wall that ſeems to cauſe the obſcurity, to that place to which the light is required; and if, when looking upward along that line, an ample ſpace of the clear ſky may be ſeen, the light to that place will not be obſtructed; but if beams, lintels, or floors, interfere, the upper parts muſt be opened, and thus the light be admitted. The upper rooms are thus to be managed: on whatſoever part of the heavens the proſpect may lie, on that ſide the places of the windows are to be left, for thus the edifice will be beſt enlightened. As in tricliniums and ſuch apartments, the light is highly neceſſary, ſo alſo is it in paſſages, aſcents, and ſtair-caſes, where people carrying burthens frequently meet each other.

(2*) This ſentence ſuggeſts an idea that the term *culina* did not always, and does not here, ſignify that particular apartment which we call the kitchen, for it is not probable that ſtalls for cattle ſhould ever have been placed within ſuch an apartment: it ſeems likely that it ſignifies the farm-yard or court, and alſo the whole pile of buildings relative to the farm, that may have been diſpoſed around it: ſuch a court is mentioned by the writers on the *re ruſtica*, and called *chors culina*.

(3*) *Communium parietum.* Tacitus (Ann. l. 15), ſpeaking of the regulations made after the conflagration in Nero's reign, uſes theſe words to expreſs party walls. Pliny (35. 14) alſo does (I think) the ſame; the inter-gereni, he mentions afterward, being in my opinion the partition walls within the houſe, ſeparating the different apartments, not thoſe ſeparating houſe from houſe. Vitruvius has before (at book 2, chap. 8), uſed the ſame words. See note 7, book 1, chap. 1.

I have explained as well as I have been able the diſtributions of our buildings, that they may not be unknown to thoſe who build; I ſhall now alſo briefly explain the diſtribution of houſes, according to the cuſtom of the Greeks, that they alſo may not be unknown.[4*]

CHAPTER X.

Of the Diſpoſition of the Houſes of the Greeks.

Fig. LXI. THE Greeks uſe no atrium, nor do they build in our manner; but from the gate of entrance they make a paſſage (*A*) of no great breadth: on one ſide of which is the ſtable (*B*), on the other, the porters rooms (*C*), and theſe are directly terminated by the inner gates. This place between the two gates is called by the Greeks *thyroreion*. After that, in entering, is the periſtylium (*D*), which periſtylium has porticos (1, 2, 3) on three ſides. On that ſide which looks to the ſouth are two antæ (*E*), at an ample diſtance from each other, ſupporting beams, and ſo much as is equal to the diſtance between the antæ, wanting a third part, is given to the ſpace inwardly; this place (*F*) is called by ſome *proſtas*, by others *paraſtas*. From this place more inwardly the great œci (*G*) are ſituated, in which the miſtreſs of the family with the work-women reſide. On the right and left of the proſtas are cubiculæ (*H*), of which one is called *thalamus*, and the other *amphithalamus*; and in the ſurrounding porticos, the common tricliniums, cubiculams, and family rooms (*I*) are erected. This part of the edifice is called *ginæconitis*.

Adjoining to this is a larger houſe, having a more ample periſtylium (*K*), in which are four porticos (4, 5, 6, 7) of equal height, or ſometimes the one (7), which looks towards the ſouth, has higher columns: and this periſtylium, which has one portico higher than the reſt,

(1*) In this deſcription, Vitruvius has only treated of the apartments and conveniences of the huſbandry part of villas, and not of the maſter's dwelling, called the villa urbana, or pſeudo-urbana, as he expreſſes it in the foregoing chapter; and which he ſays is to be governed by the ſame rules as he has delivered for city houſes, with the exceptions there mentioned. The deſcription he gives, however, is not ſo definite as to authoriſe any one particular diſpoſition, and no other; he only mentions the general aſpects and connections of the ſeveral apartments: every different villa may have differed in its particular diſtribution according as the ſituation, nature of the ground, or other circumſtances, might render proper or neceſſary; and the deſign, Fig. LIX. and LX. is only offered as one mode of diſtribution, conforming to the deſcription of Vitruvius and other antient authors as nearly as has occurred to me.

is termed *Rhodian.* In theſe houſes they have elegant veſtibulums, magnificent gates, and the porticos of the periſtyliums are ornamented with ſtucco, plaiſter and lacunariæ, of inſide work (wood). In the porticos which look to the north are the Cyzicene triclinium (*L*), and pinacothecæ (*M*); to the eaſt are the libraries (*N*), to the weſt, the exedræ (*O*), and in thoſe looking to the ſouth are the ſquare œci (*P*), ſo large, that they may eaſily contain four ſets of dining couches, with the attendants, and a ſpacious place for the uſe of the games. In theſe œci are made the men's dining couches, for it is not their cuſtom for the mothers of families to lie down to dine.[1*] This periſtylium and part of the houſe is called *andronitides*, becauſe here the men only are invited, without being accompanied by the women.

On the right and left alſo, ſmall houſes (*Q*) are erected, having proper gates, tricliniæ, and convenient cubiculæ (*R*), that when ſtrangers arrive, they may not enter the periſtylium, but be received in this hoſpitalium: for when the Greeks were more refined and opulent, they prepared tricliniæ, cubiculæ, and proviſions, for ſtrangers; the firſt day inviting them to dinner, afterwards ſending them poultry, eggs, herbs, fruits, and other productions of the country. Hence the pictures repreſenting the ſending of gifts to ſtrangers are by the painters called *xenia.* Maſters of families, therefore, while they abode in the hoſpitium, ſeemed not to be from home, having the full liberty of retirement in theſe hoſpitaliums. Between the periſtylium and hoſpitalium are paſſages (*S*), which are called *meſaulæ*, becauſe they are ſituated between two *aulæ*: theſe are by us called *andronas*; but it is remarkable that the Greeks and Latins do not in this agree; for the Greeks give the name of *andronas* to the œcus where the men uſually dine, and which the women do not enter.

It is the ſame alſo with ſome other words, as *xyſtus*, *prothyrum*, *telamones*, and others, for *xyſtos* is the Greek appellation of thoſe broad porticos, in which the athletæ exerciſe in winter time; whereas, we call the uncovered ambulatories *xyſtos*; and which the Greeks call *peridromidas.* The *veſtibula*, which are before the gates, are by the Greeks called *prothyra*; whereas, we call *prothyra* that which the Greeks call *diathyra.* The ſtatues of men bearing mutules or cornices we call *telamones*, for what reaſon is not to be found in hiſtory; but the Greeks call them *Atlantas*; Atlas being in hiſtory repreſented as ſupporting the world; for he was the firſt who, by his ingenuity and diligence, diſcovered and taught mankind the courſe of the ſun and moon, the riſing and ſetting of all the planets, and the revolutions of the heavens;

(1*) The antients had muſic and other entertainments performed before them while at their meals. This cuſtom is indicated in ſeveral antient baſſo-relievos, and there are ſome in which a woman appears ſitting while the man is lying on the dining couch: of the latter kind, one was ſeen by Mr. Stuart, over the door of a church at Athens, a copy of which I have ſeen among his ſketches.

for which benefit the painters and ſtatuaries repreſented him bearing the whole earth, and the Atlantides his children, which we call *Vergilias*, and the Greeks *Pleiades*, are placed among the ſtars in the heavens. I have not, however, mentioned this in order to change the cuſtomary names or manner of diſcourſing, but only to explain them, that theſe things might not be unknown to the lovers of knowledge.

I have now deſcribed the cuſtomary formation of houſes according to the Italian and Greek manners, with their reſpective ſymmetry and proportions; as therefore I have before written of beauty and decor, I ſhall here treat of the ſtability of edifices, and how they may be made to endure for a long time without decay.

CHAPTER XI.

Of the Stability of Edifices and of their Foundations.

IF edifices, which are built level with the ground, have their foundations conſtructed in the manner we have explained in the foregoing books that treat of walls and theatres, they will without doubt endure to a great age; but if vaults and arches are to be made, the foundations ſhould be thicker than the walls of the ſuperſtructure; and the walls, piers, and columns, ſhould be diſpoſed perpendicularly over the middle of thoſe below them, that they may ſtand firmly; for if walls or columns overhang, they cannot long remain firm. Lintels (liminæ) between piers and antæ, will not be damaged if poſts be ſet under them, for lintels and beams, when overloaded in the middle, occaſion fractures in the building; but when poſts are placed under them, and wedged, the beams cannot ſettle or be damaged. It likewiſe may be ſo ordered that the weight of the walls may be diſcharged by arches of wedges[1*] correſponding to their centers; for if over the beams or heads of the lintels arches be turned, firſtly, the weight being removed, the timbers will not bend, and then if they ſhould be decayed by age, they may, without the trouble of propping, be eaſily changed.

(1*) The ſtones forming an arch are cut in the form of a wedge, whence Vitruvius ſo calls them, and I have choſen to retain his manner of ſpeaking.

In edifices which are built with piers and arches of wedges with the joints tending to their centers, the extreme piers are to be made of a greater breadth, that they may reſiſt the force when the wedges, preſſed by the weight of the walls, and impelling toward the center, thruſt againſt the abutments; for in that caſe, if the angular piers be of a greater breadth, they will, by confining the wedges, give firmneſs to the work: as great attention is to be given to this article, ſo likewiſe is it to be obſerved, that all walls ſtand perpendicularly, and in no part overhang.

But the greateſt care ought to be taken in the foundation, becauſe it is often greatly damaged by the (internal) maſs of earth; for this is not always of the weight it is in ſummer. In winter time, by imbibing the rain-water it will be greatly increaſed both in weight and ſize; and will rupture and extrude the incloſing walls. To prevent this effect, therefore, it muſt be thus ordered; firſt, the thickneſs of the wall is to be proportioned to the magnitude of the maſs, and then anterides or eriſmæ[2*] (*A*) are to be erected in the front ſo far apart as is equal to the height of the foundation. Their thickneſs is to be the ſame as that of the foundation wall; and their projection at bottom is alſo to be equal to the thickneſs of the ſame wall; from thence diminiſhing gradually, till at the top they may be as prominent as the thickneſs of the work[3*]; moreover, adjoining to the inſide of the wall, toward the maſs of ground, teeth (*BB*) formed like thoſe of a ſaw, are to

Fig. LXII.

(2*) Buttreſſes or counterforts.

(3*) Both Perrault and Galiani have in this place deviated from the text, the latter without taking any notice of ſuch deviation.

They ſay, that the anterides or eriſmæ ſhould at bottom project from the wall as much as the height of the wall, whereas the text clearly expreſſes, "quam craſſitudo "conſtituta fuerit ſubſtructionis"—"as much as the "thickneſs of the wall." Their reaſon for this ſeems to be, that as Vitruvius adds, "deinde contrahentes gra-"datim ita uti ſummam habeant prominentiam quanta "operis eſt craſſitudo"—"from thence diminiſhing gra-"dually, till at the top they are as prominent as the "thickneſs of the work," and underſtanding by this, that the projection of the eriſmæ at the top is alſo to be equal to the thickneſs of the wall, and to increaſe gradually as they approach toward the bottom, they conclude that the text was erroneous in one or other of thoſe paſſages, accordingly they have fixed on the former, and altered it as above mentioned; although it is clearly and determinately expreſſed, leaving the latter paſſage (which is indeed vague and doubtful) unaltered: for this latter paſſage may be underſtood to ſignify, that the anterides ſhould project at the top of the foundation no more than is ſufficient to receive the thickneſs of the work of the ſuperſtructure with its projecting pilaſters, &c. as ſhewn in Fig. LXII. by the profile of the anterides *F. G.* In this ſenſe Barbaro has underſtood it; and that this is the true ſenſe, the determinate manner in which the quantity of the projection at bottom and the diminution from thence upward is expreſſed, and in which all the copies agree, renders it highly probable.

Perrault remarks, that as Vitruvius aſſigns the diſtance of the anterides to be equal to the height of the wall, the anterides will conſequently be fewer as the wall is higher, which ought to be directly the contrary, and ſhould be more numerous and cloſer in proportion as the wall is higher, as being in that caſe weaker and wanting more ſupport; he therefore ſuppoſes we ſhould read *craſſitudo* inſtead of *altitudo*, and that the diſtances ſhould be equal to the thickneſs of the wall: but this is taking it for granted that the wall, whether high or low, is to be always of the ſame thickneſs; whereas it is always underſtood that walls are to be made thicker in proportion as they are higher, and, as Vitruvius before ſays, in pro-

be built, each tooth projecting ſo far from the wall as is equal to the height of the foundation; the thickneſs of the walls of the teeth being equal to that of the foundation wall. At the extreme angle (*C*) an extent (*CD*) equal to the height of the foundation, is marked off on both ſides; from the interior angle, and from thoſe marks, a diagonal wall (*DD*) is built; from the middle (*E*) of which, another wall (*EC*) is adjoined to the angle of the wall. Thus the teeth and diagonal walls will not ſuffer the weight of the earth to preſs againſt the (foundation) wall, but will divide and reſtrain the preſſure of the maſs.

I have thus explained how works may be executed without defect, and the cautions to be uſed in the beginning; for with regard to the tiles, joiſts, or affers, the ſame care is not required, becauſe theſe, when defective, are eaſily changed. I have alſo explained the means by which thoſe things that are adjudged to be not ſolid may be made firm.

What kind of materials ſhould be uſed is not in the power of the architect to determine, becauſe all kinds of materials are not produced in all places, as is obſerved in the annexed books; beſides it is at the option of the proprietor whether he will build with brick, or rubble, or hewn ſtones. All buildings may be conſidered in a threefold view; that is, the excellence of the workmanſhip; their magnificence; and the deſign (diſpoſitio): when a work is completed with all poſſible magnificence, the coſtlineſs is admired; when it is well executed, the ſkill of the workmen is approved: but when the beauty reſulting from the proportions and ſymmetry ſhall be commended, it will be to the glory of the Architect; and this is moſt likely to happen when he patiently hears advice from the workmen, and even from the ignorant; for all men, and not only architects, may diſcover what is right (in a building). But between them and the ignorant there is this difference; the ignorant know not how it will appear till they ſee it done; whereas Architects, as ſoon as it is formed in their minds, and before it is begun, have a conception of its beauty, convenience, and decor.

I have now written as clearly as I am able what I have thought neceſſary concerning private buildings, and how they ſhould be built: concerning their finiſhing, ſo that it may be elegant, and endure without defect for a long time, I ſhall treat in the following book.

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portion to the greatneſs of the maſs of ground they encloſe. Conſidering it in this light therefore, the height and thickneſs of the walls and the diſtance of the anterides will be in the ſame proportion to each other in all caſes, and of courſe be proportionally firm and ſtrong.

Vitruvius leaves it uncertain whether the thickneſs of the teeth and diagonal wall D, at the angles, is excluded or included, in the projection he aſſigns them, from the main wall. I have determined for the former, as otherwiſe thoſe diagonal walls would not bear againſt the anterides, which, as being the ſtrongeſt part of the wall, they ought to do.

END OF THE SIXTH BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE SEVENTH.

PROEM.

THE ancients wiſely and uſefully by means of their writings delivered their knowledge to poſterity, ſo that not being loſt, but increaſing by the volumes publiſhed in every age, the utmoſt poſſible degree of ſcience might in time be attained. Not ſmall therefore, but great thanks to them are due, ſince they have not with invidious ſilence ſuppreſſed, but with care tranſmitted to us by their writings the memory of all kinds of knowledge: had they not done thus, we ſhould not know the exploits that happened at Troy; what Thales, Democritus, Anaxagoras, Xenophanes, and other philoſophers, have thought of the nature of things; what Socrates, Plato, Ariſtoteles, Zeno, Epicurus, and others, have determined concerning the duties of human life; or the actions of Crœſus, Alexander, Darius, and other kings; nor could the means by which they were done be known, unleſs the ancients had by their precepts and commentaries preſerved the memory of them to poſterity. As to theſe therefore our thanks are to be given, ſo on the contrary thoſe who, ſtealing from their writings, publiſh them for their own, are to be cenſured; and thoſe alſo who take not the evident meaning of authors, but invidiouſly glory in perverting it, not only deſerve reproof, but as living with ill intentions, ought to be condemned to puniſhment. It is reported that ſuch things were ſtrictly avenged by the antients, ſome examples of which, as they are tranſmitted to us, it will not be foreign to the purpoſe to recite.

The Attalic kings, ſtimulated by their great love for philoſophy, founded, for the benefit of the community, the excellent library of Pergamus. Ptolemy alſo at that time, incited by a great deſire and zeal for literature, with no leſs aſſiduity endeavoured in the ſame manner to eſtabliſh that of Alexandria. But when by the utmoſt exertions he had completed it, he thought it not ſufficient unleſs he could, like the propagation of ſeed, cauſe it to increaſe. For this purpoſe he inſtituted games, dedicated to Apollo and the Muſes, and appointed rewards and honours to the victorious in literature, in the ſame manner as in the games of the athletæ. This ſettled, when the time of the games approached, men of learning were appointed to be judges; the king had, from the city, already ſelected ſix, and not readily finding a ſeventh who was qualified, he applied to thoſe who ſuperintended the library: enquiring if they knew of one who was proper, they replied, there was one Ariſtophanes, who with great attention and aſſiduity came every day to read the books according to their order. At the convention of the games, therefore, when the ſeats of the judges were ſet apart, Ariſtophanes was ſummoned with the reſt, and ſeated in the place deſigned for him.

The firſt brought to the conteſt were the poets; when theſe had recited their verſes, the people unanimouſly ſignified to the judges which they ſhould prefer: when therefore the opinion of each was aſked, ſix of them adjudged the firſt premium to him whom they obſerved had moſt pleaſed the multitude, and the following accordingly; but when the opinion of Ariſtophanes was demanded, he adjudged the firſt prize to him who had leaſt pleaſed the people; this exciting the indignation of the king, and the whole aſſembly, he aroſe, and requeſted leave to ſpeak. Silence being made, he informed them, that this one was the only poet, the reſt had recited the verſes of others; and it behoved the judges not to approve robbers, but authors. While the people were wondering, and the king doubting, he, truſting to his memory, quoted many books from ſundry repoſitories, and comparing them with what had been recited, forced a confeſſion from the plagiariſts themſelves: upon which the king ordered them to be proceeded againſt as robbers, and being condemned to ignominy, diſmiſſed; but he liberally rewarded Ariſtophanes, and appointed him the ſuperintendant of the library.

Some years afterward Zoilus from Macedonia, who aſſumed the ſurname of Homeromaſtix (Homer's ſcourge) came to Alexandria, and repeated before the king his writings againſt the Iliad and the Odyſſey. When Ptolemy perceived that the father of poets, and of philoſophy, and whoſe works are admired by all nations, was, though abſent, reviled and cenſured, filled with anger he gave him no anſwer: Zoilus therefore, after waiting a long time in that kingdom, preſſed by want, ſupplicated the king for ſome gratuity; but it is ſaid, the king replied, Homer, who has been dead more than a thouſand years, has in

every age ſince provided for many thouſands of men; he then who pretends to greater abilities ought to be able to provide not only for himſelf, but alſo for many more. In fine, his death, he being condemned as a parricide, is variouſly related; ſome write that he was crucified by Philadelphus; ſome, that he was ſtoned; and others, that he was burnt alive at Smyrna: but whichever happened, he well deſerved the puniſhment, for no otherwiſe does he merit, who cenſures thoſe who cannot anſwer concerning the ſenſe of what they have written.

I therefore, O Cæſar, in this publication, have neither changed the titles of the books of others and prefixed my own name, nor have I, by cenſuring the opinion of others, endeavoured to applaud myſelf; but pay infinite honour to all authors who, with judgment and ingenuity, have provided for us an abundance of various kinds of knowledge; by which means, like drawing water from ſprings, and conducting it to the intended places, we are enabled to write on ſubjects more copiouſly and expeditiouſly, and, ſupported by ſuch authorities, we may even be enabled to produce new works. I having ſuch aſſiſtance, from thoſe by whom the principles of my ſubject have been prepared, have endeavoured to advance farther.

Agathareus of Athens, at the time Æſchylus taught there, was the firſt who made the tragic ſcene, and left a diſſertation thereon; from this example, Democritus and Anaxagoras wrote on the ſame ſubject, teaching how to project the rays from the point of ſight, fixed at a certain place as the centre, to which the lines naturally tend: thus by uncertain things repreſenting the certain appearances of buildings on the face of the ſcene; and, though deſcribed on a direct plane, ſome appear to recede, and ſome to project. Afterward Silenus publiſhed a volume on the Doric ſymmetry; Theodorus wrote of the Doric temple of Juno at Samos; Cteſphon and Metagenas of the Ionic temple of Diana at Epheſus; Phileos[1*] of the Ionic temple of Minerva at Priene; Jetinus and Carpion of the Doric temple of Minerva in the citadel of Athens; Theodorus Phocæus of the dome at Delphos; Philo of the ſymmetry of ſacred edifices, and of the arſenal at the port of Pyræus; Hermogenes of the Ionic pſeudo-dipteral temple of Diana at Magneſia, and of the monopteral temple of Bacchus

(1*) In the firſt chapter of the firſt book the architect of the temple of Minerva at Priene is called Pythius, wherefore Galiani ſuppoſes one or the other to be a miſtake of the copyiſts: but it is to be obſerved, that Phileos is not here mentioned as the architect, but only as the author of a treatiſe upon that temple; and if it ſhould be admitted that he was alſo the architect, it may have been upon the rebuilding of that temple, which was about the time of Alexander, as the inſcription publiſhed in the Ionian Antiquities, page 15, renders probable, the firſt temple (to which Pythius may have been the architect) having been deſtroyed by Xerxes, among the reſt of the Ionian temples.

at Teos; Argelius of the Corinthian ſymmetry, and of the Ionic temple of Eſculapius at Tralles, on which it is ſaid he worked with his own hands; Satyrus and Phyteus of the mauſoleum, in which they have been exceedingly fortunate, ſince thoſe whoſe ſkill has been admired in all ages, and gained immortal honour, have contributed their excellent works; for in the ſeveral fronts particular parts were undertaken to be wrought and ornamented by particular artiſts, as Leochares, Bryaxes, Scopax, Praxiteles, and alſo, as ſome think, Timotheus, and their great excellence in their arts has cauſed this work to be accounted one of the ſeven wonders of the world.

Many leſs famous have alſo written precepts upon ſymmetry, as Nexaris, Theocydes, Demophilos, Pollis, Leonides, Silanion, Melampus, Sarnacus and Euphranor; nor have there been fewer writers upon mechanics, as Diades,[2*] Architas, Archimedes, Cteſibios, Nymphodorus, Philo Byzantæus, Diphilos, Democles,[3*] Charidas, Polyidos, Phyros, and Ageſiſtratos: from whoſe writings I have collected in one body what I thought to be moſt uſeful, and that the rather, as I have obſerved many volumes have been publiſhed on theſe ſubjects by the Greeks, but very few by us; for it is wonderful that Fuſſitius was the firſt among us who publiſhed a book thereon. Terentius Varro alſo, in his treatiſes concerning new ſciences, wrote one on Architecture, and Publius Septimius two; ſince which, to this time, no one has written on the ſubject, although there muſt have been ſome great architects among the antient citizens, who were able to have written judiciouſly, ſince after the architects Antiſtates, Calleſchros, Antimachides, and Porinos, had raiſed the foundation of the temple of Jupiter Olympius, which Piſiſtratus commanded to be built at Athens, and which at his death had been relinquiſhed on account of the troubles of the republic for about two hundred years, when king Antiochus undertook to be at the expence of the work—Coſſutius, a Roman citizen, was then appointed to be the architect; and he, with great judgment and ſcience, determined the dimenſions of the cell, the dipteral diſpoſition of the columns around, and diſpoſed the epiſtylium and other ornaments according to the rules of ſymmetry; and this is no common work, but is equalled by few in magnificence, for but in four places are there temples, enriched with marble work, from which the names of thoſe places derive great celebrity, and of which the excellent and judicious contrivance is admired in the aſſembly of the gods.

(2*) Diades is again mentioned at the 19th chapter of the 10th book. In all the printed editions that I have ſeen, excepting that of Perrault, it is, in this place, written cliades; but in every manuſcript that I have examined I have found it written diades: the difference is ſuppoſed to have ariſen from the copyiſts taking d for cl, or the contrary.

(3*) Democles is omitted in the generality of the printed editions; Galiani ſays in all except that of Jocundus; but the old French edition by Jean Martin alſo has it, and I have ſeen no manuſcript without it; wherefore I have inſerted it, as Galiani alſo has in his edition of the text.

The firſt of theſe is the Ionic temple of Diana of Epheſus, begun by Cteſiphonte the Gnoſion, and his ſon Metagenes, and which afterward Demetrius the prieſt of the ſame Diana, and Peonius the Epheſian, were appointed to complete. Next, the Ionic temple of Apollo at Miletus,[4*] which the ſame Peonius and Daphnis the Mileſian conſtructed. Then, the temple of Ceres and Proſerpine at Eleuſis, in the Doric manner, by Jetinus: the cell of this was of a vaſt magnitude, and had at firſt no exterior columns, to adapt it the better for the performance of the ſacrifices; but afterward, when Demetrius Phalereus governed at Athens, Philon erected columns in the front, thereby making it a proſtyle temple; the veſtibulum being by this means enlarged, allowed more room to the ſacrificers, and added dignity to the edifice. Laſtly, the temple of Jupiter Olympius at Athens, of ample dimenſions, and of the Corinthian ſymmetry and proportions, as before mentioned, the architect of which is ſaid to have been Coſſutius, of whoſe writings none are to be found: nor from Coſſutius only are ſuch writings wanting, but alſo from Caius Mutius, by whoſe great ſkill the cells of the Marian temples of Honour and Virtue, and the ſymmetry of the columns and epiſtylium, deſigned according to the juſt rules of art, were completed. Had this work been built of marble, ſo that it might derive as much grandeur from its coſtlineſs and magnificence as it does of excellence from art, it might be named with the firſt and moſt excellent works.[5*]

It appears then that there were formerly ſome great architects of our own nation, as well as that of the Greeks, and ſeveral even in our memory; yet as they have publiſhed but few precepts, I thought it not proper alſo to remain ſilent, but to explain the different parts of the art in different books: as therefore I have in the ſixth book written of the rules that regard the building of private houſes; in this, which is the ſeventh, I ſhall treat of their finiſhing, and the means by which they may be made beautiful and ſubſtantial.

(4*) This temple, with thoſe of Minerva at Priene, and Bacchus at Teos, mentioned in the former part of this proem, are the three temples, the remains of which have been publiſhed in the Ionian Antiquities, under the auſpices of the ſociety of Dilletanti; by whoſe zeal for the improvement of the fine arts, and at whoſe expence, theſe valuable antiquities have been collected.

(5*) Livy, b. 37. ſays, two ſeparate temples of Honour and Virtue were built by Marcellus, the prieſts not permitting one temple to two divinities. Vitruvius has before mentioned them at b. 3. ch. 1. where, as here, he adjoins the word *Mariana*. Perrault has from this word ſuppoſed the temples to have been built by Marius, but this ſuppoſition has no authority.

Galiani underſtands them to have been ſituated at or near the trophies of Marius, yet theſe trophies are ſuppoſed to have been in the 5th region of Rome, by the Eſquiline hill, and the temples were on the Aventine hill near the gate Capena. See Nardini, page 163. So that there muſt have been ſome other reaſon for uſing the word Mariana that has not come to our knowledge.

Pliny, 35. 10. ſays, theſe temples were rebuilt by Veſpaſian.

CHAPTER I.

Of Pavements.

WE will firſt begin with pavements; which hold the chief place in the finiſhing. The utmoſt care muſt be taken that they may remain ſolid, and if they be laid on the ground, it muſt be examined whether the ſoil is intirely firm, and if ſo, it muſt be levelled, and covered with a rough ſtatumen; but if the whole or part of the ſpot ſhould be of an infirm texture, it muſt with great care be rendered ſolid by piling. In contignations (floors) it muſt be attentively obſerved that no walls be built under the pavement ſo as to touch it, but that they be detached, the boarding being ſuſpended over them; for when it is made ſolid, the contignation drying or ſettling, and the wall remaining immoveable, neceſſarily cauſes fractures on either ſide: it is to be obſerved alſo not to unite planks of the eſculus[1*] with thoſe of the oak; for as ſoon as oak receives any moiſture, it warps, and thereby cauſes fiſſures in the pavement; but if boards of the eſculus be not to be procured, and thoſe of oak are obliged to be uſed, they ſhould be cut very thin, that, having leſs force, they may be more eaſily confined by the nails; then on every joiſt the ſides of the boards are to be fixed by two nails, that the edges may not riſe by their warping in any part: as for the cerrus, fagus or farnus, they cannot endure long. The planking being done, fern, if it can be had, if not, ſtraw is to be ſtrewed over, to defend the wood from the corroſion of the lime, and then the ſtatumen is to be laid, conſiſting of ſtones not leſs than ſuch as will fill the hand: the ſtatumen being done, it is to be covered with the rudus[2*], which if new, three parts thereof is to be mixed with one part of lime, but if from old materials, five parts with

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(1*) I have mentioned this tree, and the cerrus, fagus and farnus, a little below, by the Latin names, on account of the uncertainty of their ſignifications. See chapter 9, book 2.

(2*) The rudus is explained by an anonymous antient author (publiſhed by the marquis Poleni in his Exercitationes Vitruvianæ, p. 198), to conſiſt of larger ſtones pounded and mixed with lime; *rudus eſt majores lapides contuſi cum calce miſti.* The words of the text indicate it to be compoſed of refuſe pieces of ſtones or bricks, &c. which we ſhould call rubble, and which may be either from new materials, or from ſuch as have been uſed in a former building; in which latter caſe Vitruvius directs more lime to be mixed, on account of the matter being drier, and it is then called *rudus redivivum*, being called *rudus novum* in the former caſe.

Perrault (as Galiani has obſerved) has miſtaken the ſtatumen and the rudus to be the ſame thing, which error he has probably been led into by the words *ſtatuminatione facta*, immediately following the deſcription of the *rudus*; but it is evident that Vitruvius inſerts theſe words to ſhew that the ſtatumen, as he has before deſcribed it, is to be laid firſt, and the rudus laid upon it; for he has juſt before mentioned the neceſſity of defending the boards from the lime, and it cannot therefore be ſuppoſed that he would now direct the rudus, which is compoſed of lime, to be laid immediately upon them.

two; then laying it on, it muſt be thoroughly pounded by a number of men with wooden rammers, till it be compact, and the thickneſs be three quarters (of a foot): upon this is laid the nucleus, compoſed of three parts of teſtaceous matter[3*] mixed with one part of lime, ſo that the thickneſs of the pavement may not be leſs than ſix inches. Over the nucleus the paving pieces, whether ſectiliæ or teſſeræ,[4*] are to be exactly laid with rule and level; when theſe are laid, and have a proper declination, they muſt be ſo rubbed, that, if they be ſectiliæ, no riſings may remain, whether they be oval (in ſcutulis), triangular, ſquare, or hexangular, but the whole compoſition muſt be perfectly ſmooth: if they be teſſeræ, all the angles ſhould be equal, and none riſe from the ſurface; for if the angles are not all equal and level, the ſurface will not be ſo ſmooth as it ought: the pointed tiburtine tiles are much deſired, becauſe they have no hollows or protuberances, but are rubbed flat and ſtraight upon the rubbed ſurface; when it is to be levigated and poliſhed, marble powder is ſifted, and over that is laid a coat of lime and ſand.

(3*) The word *teſta* in the text may ſignify the matter of any burnt clays, as bricks, tiles, &c.: it is ſo uſed by Vitruvius in ſeveral other paſſages, as *teſtaceum pavimentum*, in chapter 4. following.

Perrault has erroneouſly written *two* parts of this teſta is to be uſed to one part of lime, whereas the text expreſſes three parts to one.

(4*) L. 7. ch. 1. *ſive ſectilibus, ſeu teſſeris—whether ſectiliæ or teſſeræ.*—Of theſe two kinds of pavements Perrault and Galiani agree that the teſſeræ is the Moſaic kind, formed by very ſmall cubical pieces, becauſe teſſeræ was one name uſually given to the ſmall cubical bodies called dice. Philander on the contrary thinks the ſectiliæ were the Moſaic pavements, to which opinion I alſo incline; for although the word teſſeræ was uſed as one of the names of dice, yet it alſo ſignified a ſquare, or any ſquare body, and may therefore have ſignified a ſquare paving ſtone, either large or ſmall, a cube appearing a ſquare when laid in the pavement; but it probably ſignified a large ſort of ſtone, for the following reaſons. Vitruvius in this chapter ſays, that in the teſſeræ pavements it is neceſſary to work all the angles of the ſtones exactly equal or alike—*ſi teſſeris ſtructum erit ut ex omnes angulos habeant equales*, which is indeed neceſſary in large ſtones, in order that they may be regularly laid, but not in the minute pieces of which the Moſaic pavements conſiſted; becauſe their own figure was not intended to be conſpicuous, they being only uſed as the conſtituent particles of other forms; and the examples of the antient Moſaic that have come to our knowledge prove that ſuch exactneſs was not practiſed in thoſe minute pieces. Again, Vitruvius hereafter mentions *large teſſeræ two inches in thickneſs*, which plainly proves that teſſeræ ſometimes at leaſt ſignified large ſtones; for ſtones muſt be conſiderably large to require to be two inches in thickneſs. Vitruvius directs the ſectilia pavements to be rubbed ſmooth after they are laid, but he does not direct the teſſeræ to be ſo rubbed, which is an implication that theſe latter were large ſtones, that might be ſo previouſly wrought and laid as not to require rubbing afterward; but it would be very difficult or ſcarce poſſible to lay the very minute pieces of the Moſaic pavements in a ſenſibly perfect plane, and therefore they would require rubbing after they were laid.

The example Vitruvius mentions of the tiburtine tiles (which, by their being deſcribed to have no hollows or protuberances, we may infer were not very ſmall) following immediately after the mention of the teſſeræ, is a farther ſupport to the opinion that the latter likewiſe were not of the ſmall kind; large teſſeræ two inches on the edge are alſo hereafter mentioned: this at leaſt proves that all of the teſſeræ kind could not be ſo ſmall as the ſtones uſed in the Moſaic pavements, which were ſometimes leſs than half an inch, and ſeldom more than one inch cube; but as theſe are ſaid to be two inches thick, it implies that their ſurface was much larger: for theſe reaſons, therefore, I am of opinion that the ſectiliæ were the kind now commonly known by the term Moſaic, or rather Muſaic, as Vitruvius writes the word.

But pavements that are expoſed to the weather are to be made particularly ſubſtantial, becauſe the motion of the flooring either ſwelling with humidity, ſhrinking with dryneſs, or ſwagging in the middle, is apt to injure the pavement; the ice and froſt alſo prevent its remaining entire: if therefore it be neceſſary that it ſhould by no means be damaged, it muſt be thus ordered; when the planking is done, other planks muſt be laid thereon tranſverſely, and faſtened with nails, forming a double covering to the contignation; then with new rudus a third part of pounded brick is mixed, and to that two parts out of five of lime make the mortar of a proper conſiſtence. The ſtatumen being done, this rudus is laid and thoroughly pounded, ſo that it may not be leſs than a foot in thickneſs, and then the nucleus is ſpread as before mentioned: the pavement is to be formed of large teſſeræ, about two inches on the edge, the declination being two inches in ten feet, and thus, if well tempered and rubbed flat, it will remain free from all defects; but in order that the matter between the joints may not be damaged by the froſt, it ſhould be ſaturated every year, before winter, with dregs of oil, which will prevent its imbibing the froſt. If it is to be done yet more carefully, two feet tiles, jointed together, muſt be laid upon the rudus, having little channels of a finger's breadth cut in the fronts of the ſeveral joints, which joints being filled with lime tempered with oil, are compreſſed and rubbed together; by this means the lime, which remains in the channel, growing hard, ſuffers no water nor any thing elſe to penetrate the joints: this being done, the nucleus is laid thereon and beaten with ſticks, and over that either large teſſeræ or the pointed tiles are laid in the declination before mentioned, and when it is thus done it will not ſoon decay.

CHAPTER II.

Of the Preparation of the Lime for the Plaſtering and the Stucco.

THE conſideration of the pavements being finiſhed, then the plaſter[1*] is to be attended to. This will be good, if the lime-ſtones be of the beſt kind and ſlaked a long time before they are uſed, ſo that if ſome of the ſtones ſhould be too little burnt in the furnace, by being long macerated in water, they may be diſſolved, and the whole reduced to one conſiſtence; for ſhould the lime be not thoroughly ſlaked, but be uſed freſh, the concealed crude particles it may contain will, when it is laid, occaſion it to emit puſtules, becauſe theſe particles ſlaking when in the work, diſſolve, and deſtroy the ſmoothneſs of the ſtucco.

To know when it is ſufficiently macerated and properly prepared for the work, the lime is to be chopped with an ax in the manner timber is hewn: if the ax meets with lumps, it is not well tempered; and if the iron comes out dry and clean, it ſhews the lime to be periſhing and weak; for when it is fat and well macerated, it will adhere to the iron like glue, and this will be a proof that it is well tempered; then the machines being prepared, the ceilings of the apartments are to be plaſtered, unleſs they are intended to be ornamented with lacunariæ.

(1*) Some ſuppoſe the albaria, which I have rendered plaſtering, to be a ſort compoſed of pure lime, while others think it to be nothing more than a white waſh: that it is a kind of plaſter is evident, for at the 2d chapter of the fifth book, Vitruvius ſpeaks of it as the ſubſtance with which they make cornices.

Perrault thinks albaria means the ſtucco, and that tectoria is the name of the plaſtering in general. Galiani ſuppoſed albaria to ſignify all kinds of plaſtering and wall whiting whatever, and that tectoria is a name including every ſort of incruſtation wherewith the walls may be overlaid. But at the 6th chapter following the word *tectoria* is applied to that ſort of plaſter wherein powder of marble was uſed, and which therefore can be reckoned no other than ſtucco; and as Vitruvius makes a diſtinction between the two, ſaying, at chap. 10. book 5. *albaria ſive tectoria*, it is evident that the albaria cannot be ſtucco alſo: beſides, it is not to be doubted but that in this chapter Vitruvius ſpeaks of the preparation of the lime as proper for all the kinds of plaſtering, not for the ſtucco only; and he here uſes the word *albariis* at the beginning to expreſs his intention, *cum a pavimentorum cura diſceſſum fuerit, tunc de albariis operibus eſt explicandum.* I have therefore generally accepted albaria for the plaſtering of all kinds, and tectoria for the ſtucco only, except in ſome caſes, where the ſenſe was plainly different.

CHAPTER III.

Of the Conſtruction of arched Ceilings, and of the Plaſtering and Stucco Work.

WHEN arched ceilings are required, they may thus be made; parallel aſſers are diſpoſed not more than two feet diſtant from each other, and chiefly on cypreſs wood, becauſe fir is ſoon decayed by worms and age. When theſe aſſers are ſuited to the form of the curve, they muſt be faſtened to the ties fixed to the flooring or roof with nails of iron, and theſe ties ſhould be prepared from ſuch wood as neither worms, age, nor damps can hurt, ſuch as box, juniper, olive, robor, cypreſs, and ſuch kinds; the oak muſt be excepted, becauſe it warps, and cauſes cracks in the work wherein it is uſed: the aſſers being thus fixed, Greek reeds bruiſed are to be tied to them with cords of Spaniſh broom, according as the form may require; alſo upon the upper ſide of the arch a mixture of lime and ſand is to be laid, that in caſe any water ſhould fall thereon from the floor or roof, it may be abſorbed. But if Greek reeds ſhould be ſcarce, thoſe ſlender ones of the lakes are to be united and bound together with cords, as before written, and ſecured with wooden pegs; all the reſt is to be done as above written.

The arches being formed and connected, their under ſurface is to be rough plaſtered[1*], then made even with arenatum[2*], and afterward ſmoothened with chalk or marble (plaſter): when the arches are finiſhed, cornices are wrought under them, which ſhould be made as ſlender and light as poſſible, for when they are large, being loaded with their own weight, they cannot ſupport themſelves; in theſe gypſum[3*] ſhould not be mixed, but the refuſe of marble

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(1*) This firſt rough coat of plaſter is called by Vitruvius *trulliſatio*, from *trulla*, trowel, the tool wherewith it was laid: we are not here informed of its compoſition, but in the following chapter we have the words *pro arenato teſta trulliſetur*, and again *teſta trulliſetur*, which encourage an opinion that it conſiſted of lime mixed with pounded tiles or bricks.

(2*) The *arenatum* was from *arena*, ſand, it being a mortar compoſed of ſand mixed with lime; ſo the mortar wherein the powder of marble was uſed was, for the ſame reaſon, called *marmoratum*, though ſometimes granum.

(3*) Gypſum is explained by Pliny, b. 36. ch. 24. He ſays it is a kind of lime, made by burning a ſtone ſimilar to alabaſter, but the beſt is made from talc: in ſome countries it is dug out of the earth ready made by Nature. And he obſerves, that when it is wetted it muſt be uſed directly, as it then quickly becomes dry and hard. From this deſcription it appears plainly that the gypſum of the antients was that kind of plaſter which we now call *plaſter of Paris*, and the Italians *geſſo*.

reduced to a fine powder, which not drying ſo precipitately, admits the whole work to dry equally; the manner of thoſe of the antients is to be avoided, becauſe the great weight of the impending ſofites of theſe cornices renders them dangerous.

Some cornices are plain, and ſome enriched; in apartments where fire or many lights are uſed they ſhould be plain, that they may be more eaſily cleaned. In ſummer rooms and exedræ, wherein there is no ſmoke or ſoot that can hurt, there they may be enriched; for plaſtering, on account of its ſuperior whiteneſs, is eaſily ſoiled with the ſmoke ariſing not only from the building that contains it, but alſo from the adjacent houſes.

The cornices being finiſhed, the walls are to be roughly plaſtered, and thereon, while drying, the arenatum is to be laid, being regulated in length by the rule and line, in height by the perpendicular, and the angles by the ſquare; for thus the regularity of the ſtucco will improve the appearance of the pictures: again, while drying, a third coat is laid, for the more ſubſtantial the arenatum is, the more durable and ſolid will be the ſtucco. When not leſs than three coats of arenatum, excluſive of the trulliſatio (rough plaſter), are laid, then the coat of plaſter in which marble powder is mixed is to be laid; this is to be ſo tempered, that when worked it may not adhere to the tool, but leave the iron clean and free from mortar. When this is done and is dried, it is to be covered with another thinner coat, which, after being well worked and rubbed, is overlaid with one yet more thin: thus the walls being ſecured with three coats of arenatum as well as with the marmoratum, neither fiſſures nor other defects can happen; but the plaſtering, rendered ſolid by beating with ſtaves, and well levigated with white marble (powder), the colours laid thereon will appear bright and ſplendid.

Colours when carefully laid on the ſtucco, while wet, will not fade, but will always remain the ſame, becauſe the lime being deprived of its humidity in the furnace, and made porous and dry, eagerly imbibes whatever moiſture happens to touch it, and by their different properties, the particles or principles uniting together in the mixture, grow into one ſolid body on whatever part applied, and when dry are found to be ſo incorporated as to appear like one ſubſtance, and to have the ſame qualities: the ſtucco, therefore, when properly done, will neither by age become ſcaly, nor will it when cleaned diſcharge the colours, unleſs they have been laid with too little care, or after the work was dry: if then the incruſtation of the walls be done as before written, it will retain its firmneſs and ſplendour to a great age; but if one coat only of arenatum and one thin coat of marmoratum be laid, not having ſufficient ſtrength on account of its thinneſs, it eaſily cracks, nor will it retain its proper ſmoothneſs. A ſilver mirror when formed of a thin plate has but an uncertain and weak reflection; but

when it is of a ſufficient ſubſtance, it receives a ſtrong poliſh, has a ſhining appearance, and reflects images exactly and diſtinctly: and ſo the ſtucco, when of thin ſubſtance, not only cracks, but alſo ſoon decays; but if rendered ſufficiently ſubſtantial by having a proper thickneſs of arenatum and marmoratum, it will, when poliſhed, appear brilliant, and diſtinctly repreſent the figures delineated thereon.

The Greek plaſterers not only uſe theſe means to make their work ſubſtantial, but alſo put the lime and ſand mingled together into a pit, where the matter is pounded by a company of men with wooden rammers; when thoroughly tempered, it is then uſed: ſlabs thereof cut from the antient walls are uſed for abaci, and the ſame kind of ſtucco is uſed in the prominent diviſions around the abaci and mirrors.[4*] If the ſtucco is to be laid on wooden partitions, the perpendicular and tranſverſe pieces of which cauſe cracks, becauſe when they are covered with the mortar they abſorb moiſture, and then ſhrinking as they dry, occaſion fiſſures in the ſtucco; that this may not happen, the following method muſt be obſerved: After the whole wall has been plaſtered, reeds placed cloſe together are to be fixed on the

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(4*) "Itaque veteribus parietibus nonnulli cruſtas exci- "dentes pro abacis utuntur, ipſaque tectoria abacorum & "ſpeculorum diviſionibus, circa ſe prominentes habent "expreſſiones." If it is uncertain what is preciſely meant by the term abaci in the 3d book, it is particularly applied to the flat ſtones that lay upon the tops of the capitals; but its general ſignification is any flat tabulated ſubſtance. Barbaro thinks it here ſignifies tablets for painting on, and Perrault renders it tables. Galiani ſuppoſes it to ſignify bricks, and tranſlates the paſſage to this effect: "Some cut from the old walls pieces of plaſter and uſe "them for bricks, and in the ſame plaſtering diſtribute "theſe bricks ſo that they form a relievo around the "ground of the quadratures."

Though I cannot pretend to aſcertain what Vitruvius here means by the abaci, I cannot be of Galiani's opinion that they are bricks; no inſtance of plaſter being uſed for bricks by the antients has ever been known, or at leaſt come to my knowledge; and it would be very improper to be ſo uſed: it ſeems to me more likely to allude to the pannels into which the ſtucco of the walls might be divided, examples of which are ſeen in ſundry remains of antiquity; the rather alſo on account of theſe abaci being mentioned with the ſpeculi or mirrors, which are tabular ſubſtances ſimilar to ſuch pannels: and the next chapter mentions ſuch abaci being uſed to decorate the walls above the part of the podium or dado as we call it. What Galiani means by *riquadriture*, which I have rendered quadratures, I know not; he has uſed it for ſpeculorum in the Latin, which probably were the ſilver mirrors Vitruvius has before mentioned in this chapter. Galiani may mean the ſame by this word; for if he ſhould mean thereby the abaci, he muſt have uſed that word twice in the ſame ſentence for different meanings.

But the uſing theſe pieces of old plaſter to make the margins or frames around ſuch quadratures (whichever may be meant), as Galiani has tranſlated it, is highly improbable, nor does it appear to me that the Latin words have any ſuch meaning. It would be a very laborious work to cut old pieces of plaſter to make frames; it would be a much more eaſy and more ſubſtantial work to make ſuch frames or mouldings with new plaſter, though it ſhould be neceſſary to be at the pains of making the plaſter for ſuch purpoſes as good as the Greeks made it; and this is indeed my conception of the paſſage, the words *ipſaque tectoria* not, in my opinion, referring to the abaci or the old plaſter pieces cut from the walls, as the tranſlators have rendered them, but to the new plaſter or ſtucco made in the Greek manner, mentioned at the beginning of the paragraph.

work with fly-headed nails[5*]; then plaſtering the work again, a ſecond coat of reeds is to be fixed perpendicularly, provided the former were placed tranſverſely, and then the arenatum and marmoratum are to be laid as before deſcribed; thus by means of the double coat of reeds, fixed againſt the walls tranſverſely to each other, neither cracks nor fiſſures can happen.

CHAPTER IV.

Of the Plaſtering in damp Situations.

I HAVE ſpoken of the method of plaſtering in dry places; I ſhall now explain how it ought to be done in humid ſituations, ſo that it may remain undamaged.

And firſtly, in apartments on the ground ſtory, the walls are to be plaſtered and made ſtraight with brick-duſt mortar, to the height of three feet from the pavement, that in that part the ſtucco may not be damaged by the humidity; but in walls that are continually damp, another thin wall is to be built withinſide, as far diſtant from the other as neceſſary, and between the two walls a channel is to be made lower than the pavement of the apartment, having openings to ſome uncovered place; alſo, when the wall is erected, vent holes are to be left; for if the humidity have not vent at the top as well as at the bottom, it will penetrate into the new wall: this done, the wall is to be plaſtered and made even with brick-duſt mortar, and then ſmoothed with ſtucco. If the place ſhould not admit of a wall being built, channels are to be made, with holes from thence to the outſide; then two feet tiles are laid, one ſide reſting on the margin of the channel, the other on little eight inch brick piers, upon which the angles of two tiles may reſt, and not be farther from the wall than one palm; upon theſe upright bent tiles are fixed from the bottom to the top of the wall, their inner ſide being well pitched, that the water may be rejected: alſo at the bottom and at the top, above the ceiling, vent holes are to be made; then the tiles are to be whitened with lime diluted with water, that the plaſtering may adhere, for on account of the dryneſs which they have acquired in the furnace, they cannot receive nor ſupport the plaſtering unleſs

(5*) *Clavis muſcariis.* Galiani obſerves that they now uſe in Italy a ſort of nails called *moſcar dini*, from the reſemblance of the head to the body of a fly; and conjectures, from the ſimilarity of their name and uſe, that they are probably the ſame ſort that were formerly uſed by the antient Romans.

lime is applied, which adhering to both ſubſtances, connects them together; with the brick-duſt mortar it is then plaſtered and made even, and all the reſt, as before written, being done, it is laſtly finiſhed with ſtucco.

Concerning the ornaments of the plaſtering, they muſt be regulated by the rules of decor; ſo that being adapted to the places, and not unſuitable to the peculiar circumſtances, they may acquire approbation.

In winter tricliniums, neither theſe ornaments nor paintings are proper, nor ſhould the cornices of the ceilings be minutely ornamented, becauſe they are ſpoiled by the ſmoke from the fire, and the ſoot from number of lights; but in theſe apartments the abaci (or pannels) above the podium are coloured black, and poliſhed with yellow or red ornaments intermixed.[1*]

When the ceilings are finiſhed and poliſhed, then with regard to the pavements it may not be amiſs to deſcribe the method uſed by the Greeks in their winter apartments, which, though leſs ſumptuous, are more convenient. They dig into the floor of the triclinium about the depth of two feet, and the bottom being well rammed, either rudus or teſtaceous pavement is laid, having an inclination toward the holes of the drains; then a compoſition is made of pounded coals, with ſand, lime, and aſhes mixed together, and laid even and level half a foot in thickneſs, and the ſurface being rubbed with ſtones, it appears like a kind of black pavement: and at their feaſts, the liquid that may fall thereon from the cups or their mouths, is dried up as ſoon as it falls. And even if the attendants have their feet naked, they receive no cold from theſe kind of pavements.

(1*) *Abaci exatramenta ſunt ſubigendi & poliendi, cuneis ſilaceis ſeu miniaceis interpoſitis.*

The words ſilaceis and miniaceis, which come from ſil and minium, explained in the following chapter, have been uſually tranſlated yellow and red; but *ſilaceis*, in my opinion, ſignifies all ochreous colours, not yellow only; wherefore I have choſen to give the original words.

The word cuneis is tranſlated by Perrault, triangles, and by Galiani, ſquares. I underſtand it in this caſe to ſignify either ornaments in general, or ſome particular ſort in uſe at that time.

CHAPTER V.

Of the Manner of Painting in Edifices.

IN other apartments, that is, in thoſe for ſpring, autumn and ſummer, as alſo in the atrium and periſtylium, the ancients have eſtabliſhed certain methods of painting. A picture is the repreſentation of things that are, or may be; as men, buildings, ſhips, and other things; of which the copy, by having the exact form and outlines of the real body, aſſumes the likeneſs. The ancients, who originally inſtituted this manner of decoration, at firſt imitated the varieties and marks of marble incruſtation, then cornices, diſpoſing between them divers ſilaceous and miniaceous coloured ornaments: they proceeded afterward to repreſent edifices, with columns and pediments projecting; but in ſpacious places, ſuch as exedræ, on account of the amplitude of the walls, they repreſented the fronts of ſcenes in the tragic, comic, or ſatyric manner; and ambulatories, being of a great length, they ornamented with landſcapes, expreſſing the appearances of particular places, painting harbours, promontories, ſea-coaſts, rivers, fountains, canals, temples, groves, mountains, cattle and ſhepherds; in ſome places alſo, large paintings of figures, repreſenting the gods, or fabulous hiſtories; the Trojan war, or the wanderings of Ulyſſes, and other ſubjects of a ſimilar kind, which are conformable to the nature of things.

But theſe ſubjects, which our forefathers copied from nature, are now, by our depraved manners, diſapproved; for monſters, rather than the reſemblances of natural objects, are painted on the ſtucco; reeds are ſubſtituted for columns, and for the pediments, fluted harpaginetuli[1*], with curling foliage and volutes; alſo candelabra ſupporting the forms of little buildings, their pediments riſing out of roots, with numerous volutes and tender ſtalks, having, contrary to reaſon, images ſitting on them; ſo alſo the flowers from ſtalks have half figures ſpringing therefrom with heads, ſome like thoſe of men, ſome like thoſe of beaſts, which

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(1*) The word harpaginetuli has exerciſed the ingenuity of all the commentators hitherto; their conjectures concerning its ſignification are very various, and ſome far fetched; the moſt probable ſeems to be that it is derived from *harpago*, *an hook*, and that it means ſome kind of ornament or ſcroll, in imitation of ſuch an inſtrument: but it will be beſt explained by referring to the Herculanean paintings, where various groteſque ornaments are ſeen to be ſubſtituted for the faſtigiums or pediments of the ſeveral buildings there repreſented.

things neither are nor can be, nor ever were: and this new mode ſo prevails that thoſe who are not judges, diſregard the arts; for how is it poſſible for reeds to ſupport a roof; or candelabra, buildings and the ornaments of pediments; or ſtalks, which are ſo ſlender and ſoft, ſitting figures; or the flowers of ſtalks produce half images? Yet men, being accuſtomed to the ſight of theſe abſurdities, do not cenſure, but are pleaſed with them, without conſidering whether they be proper or not; the judgment, depraved by habit, examines not whether they be according to propriety and the rules of decor; for pictures ſhould not be approved unleſs they be conformable to truth, even although they be well executed; they ought therefore to be immediately condemned, unleſs they can bear the trial of rational examination, without being diſapproved.

Thus at Tralles, when Apaturius of Alabanda had excellently well painted a ſcene in the little theatre, which with them is called the *Eccleſiaſterion*, and inſtead of columns had placed ſtatues and centaurs, ſupporting the epiſtylium, the circular roof of the dome, and projecting corners of the pediments, and ornamented the cornice with lions' heads, all which have reference to the roofing and eaves of edifices; above theſe nevertheleſs in the epiſcene, domes, porticos, ſemi-pediments, and all the various parts of buildings were again painted: wherefore upon the appearance of this ſcene, when by reaſon of its enrichment it was found pleaſing to all, and they were ready to applaud the work, Licinius the mathematician then advanced and ſaid, "the Alabandines are ſufficiently intelligent in all civil affairs, but

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(2*) Galiani obſerves that Pliny, 35. 10. ſays this ſtyle of painting was invented in the time of Auguſtus, by Ludius; but adds, it is more probable that Ludius was only the propagator, as Vitruvius *here ſays it was in uſe even before his time*. This ſuppoſition ariſes from Galiani taking it for a fact that Vitruvius wrote in the time of Auguſtus; but as there appears no reaſon to doubt the aſſertion of Pliny in this caſe, the paſſage is rather an evidence that Vitruvius wrote after the time of Auguſtus, ſince he intimates that it had been invented and in uſe before the time he wrote: but the fact is, Galiani has miſtaken the ſtyle of painting Pliny ſpeaks of; it is not the groteſque ſtyle here cenſured by Vitruvius, but the approved ſtyle that he has immediately before mentioned and ſaid was uſed by the ancients: this will be evident by comparing the deſcriptions of the two authors, in which ſeveral of the words made uſe of are the very ſame.—Pliny, b. 35. ch. 10. ſays, "non fraudando & Ludio & divi "Auguſti ætate, qui primus inſtituit amœniſſimam parie- "tum picturam, villas & porticus ac topiaria opera, lucos, "nemora, colles, piſcinas, euripos, amnes, littora, &c.— "not to deprive of due honour, Ludius, who, in the "time of the deified Auguſtus, firſt invented that moſt "pleaſant manner of painting the walls with villas, por- "ticos, landſcapes, woods, groves, hills, fiſh-ponds, "canals, rivers, ſea-coaſts, &c." Theſe are all real objects, ſimilar to thoſe Vitruvius enumerates and approves. This ſtyle, Pliny ſays, was invented in the time of Auguſtus, and this is the ſtyle Vitruvius ſays was invented and uſed by the ancients, but which at his time had given place to the groteſque ſtyle. Theſe circumſtances, therefore, muſt amount almoſt to demonſtration that Vitruvius wrote at a time long after that of Auguſtus: this may therefore be added to the arguments on that conteſted point, in the Obſervations on the Life of Vitruvius.

The groteſque kind of painting was firſt diſcovered by the moderns in the baths of Titus at Rome, and was imitated by Raphael at the Vatican; ſince which it has continued to be in uſe. It is ſaid to have obtained its name from being firſt ſeen in vaulted apartments, which being almoſt buried in the earth and ruins, appeared like caves or *grottos*, from whence came the term *groteſque*.

for a trifling impropriety are deemed injudicious; for the ſtatues in their gymnaſium are all in the attitude of pleading cauſes, while thoſe in the forum are holding the diſcus, or in the attitude of running or playing with balls; ſo that the unſuitableneſs of the attitudes of the figures to the purpoſes of the places, throws a public diſgrace upon the city. Let us then take care that by the ſcene of Apaturius we are not deemed Alabandines, or even Abderites[3*]; for who among you places upon the tiles of the roofs of your houſes columns or pediments? Theſe things are placed upon the floors, not upon the tiles. If then we approve in painting what cannot be in fact, we of this city ſhall be like thoſe who, on account of the ſame error, are deemed illiterate." Apaturius dared not to reply, but took down the ſcene and altered it ſo as to be conſiſtent to truth; after which it was approved. I wiſh the immortal gods would reſtore Licinius to life, that he might correct this folly, and faſhionable diſfigurement of our ſtucco work: but why a falſe overcomes a juſt mode, it will not be foreign to the purpoſe to explain.

The ancients, with labour and application, endeavoured to make their works be approved by the excellencies of art; this is now ſupplied by the beauty of colours, and the uſe of thoſe of the moſt coſtly kind; and that value which was formerly given to works by the ſkill of the artiſt, is not deſired, ſince the expence of the proprietor ſupplies its place. Who among the ancients is known to have uſed minium otherwiſe than ſparingly and as a medicine? But now it is every where laid over the whole wall; it is the ſame with cryſocolla, oſtrum and armenium, which when laid, although without any art, appear very brilliant to the ſight; and they are ſo coſtly, that it is uſually ſpecified in the articles of agreement that they ſhall be purchaſed by the proprietor and not by the contractor.

I have explained as well as I am able the means by which defects in the ſtucco work may be avoided: I ſhall now ſpeak of the other requiſite materials as they may occur; and as the lime has been before mentioned, the marble (powder) remains to be treated of.

(3*) The Abderites was a nation proverbially accounted ſtupid.

CHAPTER VI.

Of the Preparation of Marble Powder for the Stucco.

MARBLE of the ſame kind is not produced in all countries; but in ſome places there grow pieces that have pellucid particles like ſalts, which being pounded and ground, is very proper for the ſtucco work and cornices: but in places where plenty of theſe are not to be had, the marble chips or aſſulæ, as they are called, which come from marble in working it, are to be pounded with iron peſtles, and ſifted in ſieves; then being ſeparated into three ſorts, the larger ſort, mixed with lime, as before deſcribed for the arenatum, is firſt laid, then the ſecond, and laſtly the third, which is the fineſt ſort: theſe being laid, and the ſtucco well levigated and rubbed, the colours are next to be conſidered, that they may appear bright and ſplendid: the differences and preparation of theſe are as follow.

CHAPTER VII.

Of Colours, and firſt of Ochres.

SOME colours are generated in certain places, and are dug from thence; ſome are produced from working, combining, or tempering other things ſo as to anſwer the ſame purpoſe in the work: but we will firſt diſcourſe of thoſe which grow of themſelves, and are dug out of the earth.

That which the Greeks called *ochræ* is found in many places as well as in Italy, but the beſt is that of Attica, which is not now to be had: but at the time the ſilver mines at Athens were wrought, whenever in digging they found a ſtrong vein (of ochre), they followed it as if it

had been ſilver; the ancients therefore had plenty of excellent ſil[1*] for the colouring of their ſtucco work. Rubrica[2*] is alſo found plentifully in many places; but the beſt at few, as at Sinope in Pontus, and in Egypt, in the Spaniſh Balearic iſlands, as well as at Lemnos, the revenue of which iſlands, the ſenate and people of Rome granted to the Athenians.

Parætonium takes its name from the place where it is dug; ſo alſo does melinum[3*], which mineral is ſo called from Melus, one of the iſlands of the Cyclades. Green earth grows alſo in many places, but the beſt at Smyrna; this the Greeks call *Theodotion*, becauſe Theodotus was the name of him in whoſe land it was firſt diſcovered.

Auripigmentum[4*], which by the Greeks is called *arſenicon*, is dug at Pontus: ſandara[5*] alſo at many places, but the beſt at the mine near the river Hypanis in Pontus; in ſome places, as between the confines of Magneſia and Epheſus, are pits where it is dug ſo well prepared, that it neither requires to be ground nor ſifted, being as fine as thoſe which are bruiſed and kneaded by the hand.

(1*) Whether the ſubſtance called by the Latins *ſil* was the ſame as that the Greeks called *ochre* has been doubted: that it was the ſame ſeems to me moſt probable, as it was found as ochre is, in or near mines of metal, and was, like it, a coloured earth. Pliny, book 33. chap. 12. ſays, *Sil proprie limus eſt,—ſil is a kind of clay.* Galiani endeavours to prove by the word ſil, that the Romans meant no other coloured earth but the yellow, or that now called yellow ochre; and he alleges in favour of his opinion, that Pliny ſays the Attic and Gallic ſil was uſed for the lights of pictures, and muſt therefore be of a light colour. This is true; but Pliny alſo ſays the ſil of Syros and Lydia was uſed for the ſhades, which proves there was dark as well as light coloured ſil.

(2*) Rubrica is a red earth. Pliny, b. 35. ch. 6. ſays it was nearly of the colour of minium, which it was uſed to adulterate.

(3*) Parætonium and melinum were, according to Pliny, white earths; the former came from a place of the ſame name in Egypt, and was adulterated with boiled fullers earth.

(4*) Auripigmentum, or arſenic, as here called, is ſuppoſed to be that ſubſtance which we call orpiment. Pliny deſcribes it, b. 33. ch. 4. to be of the colour of gold. It is found, he ſuppoſes, in gold, ſilver, and copper mines, and ſometimes in beds of marle. Our orpiment is arſenic with a portion of ſulphur.

(5*) Sandara, Pliny, b. 34. ch. 18. alſo ſays is found in gold and ſilver mines, and is a little paler than arſenicum, which is of the colour of gold: at b. 35. ch. 6. he ſays it grows on the iſland of Topazus in the Red Sea; that it ought to be of a flame colour, and is counterfeited and adulterated with ceruſe or white lead burnt. I muſt notice, for the benefit of his readers, that Galiani has here, and at the 12th chapter, tranſlated *ſandaraca*, minium, or red-lead, urging as a proof, that Vitruvius there ſays ſandaraca was made by burning ceruſe: this is true; but ceruſe, by a certain degree of burning, becomes yellow, growing red when burnt in a greater degree; and the foregoing quotations of Pliny plainly prove that ſandaric was of a yellow or flame colour, paler than auripigmentum, and therefore cannot be the modern minium, which is of a bright red colour.

Pliny more nearly deſcribes minium under the name of uſta. See note 2. ch. 11. following.

There is a gum alſo called ſandaric, which is obtained from the juniper tree.

CHAPTER VIII.

Of Minium.

WE now proceed to the deſcription of minium[1*]: this is reported to have been found in the Cilbian fields of Epheſus; the ſubſtance as well as the proceſs relative thereto is ſufficiently curious; for when the maſs is dug up, before it is wrought into minium, it is called *anthrax:* it appears like the ore of iron, but is a little redder, having a red powder about it after it is dug; being beaten with iron inſtruments, it yields many drops of quickſilver, which the miners immediately gather. When the maſſes are collected in the laboratory, being full of moiſture, they are thrown into a furnace to be thoroughly dried; and that vapour which is raiſed from them by the heat of the fire is, when it ſubſides on the floor of the furnace, found to be quickſilver: the maſſes are then taken out, and the drops that remain, being too ſmall to be collected, are poured into a veſſel of water, where they run together and unite. This quickſilver, when it meaſures four ſextarii, will be found to weigh one hundred pounds; and being put into any veſſel, if a ſtone weighing a hundred pounds is laid thereon, it will ſwim on the ſurface, nor can it by its weight depreſs, daſh over, or diſperſe the liquid; yet upon removing the hundred weight, if a ſcruple of gold be laid thereon, it will not ſwim, but ſink to the bottom by its own weight.[2*] It is therefore not to be denied that the gravity of bodies is not owing to the greatneſs of their weight, but to their peculiar nature.

Quickſilver is found ſerviceable for many purpoſes; for without it, neither ſilver nor braſs can be properly gilded; and when garments embroidered with gold are decayed by age,

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(1*) The ſubſtance which we call minium is a preparation of lead, being ceruſe or white lead burnt till it becomes red; thence alſo called red lead: but the minium of the antients appears by the deſcription to be that ſubſtance which we know by the name of native cinnabar, or vermilion. Pliny, b. 33. ch. 7. ſays it is found in ſilver mines, was firſt diſcovered by Callias, an Athenian, in the 349th year of Rome, is in colour like coccum, (which we call kermes), and like the hæmatites or blood-ſtone burnt. He obſerves, ſome erroneouſly called it cinnabar, which was the Indian name of dragon's blood; and that on account of the dearneſs of both cinnabar and minium, they uſed rubrica and ſinopis in their ſtead.

He alſo deſcribes another ſort of minium found in lead and ſilver mines, and which is not red till it is burnt: this may probably be a part of the metal corroded by ſome acid in the mine, and thereby brought to the ſtate of ceruſe, and which, like it, when burnt, turns red; with this and ſyricum, Pliny ſays they adulterated the true minium.

(2*) The ſpecific gravity of the ſtone being leſs than that of quickſilver, and that of the gold being greater.

and can no longer with decency be worn, being burnt in an earthen veſſel over the fire, and the aſhes thrown into water, upon adding quickſilver thereto, it attracts all the particles of gold, and unites them with itſelf; then the water being diſcharged, it is poured into a cloth[3*], and there preſſed with the hands, by which the quickſilver, on account of its fluidity, is forced through the pores of the cloth, and the pure gold is found compreſſed together within.

CHAPTER IX.

Of the Preparation of Minium.

WE now return to the preparation of minium: when the maſſes are hard, they are pounded with iron tools, and ground, and then by frequent waſhing and boiling they are brought to their colour; when this ſhall be effected, then the minium, by being deprived of the quickſilver, which has in itſelf ſome natural properties, is left, and becomes of a ſoft and weak nature; therefore when laid on the ſtucco, within apartments, it retains its colour without fading: but in uncovered places, as periſtyliums, exedræ, and ſuch like, into which the ſun and moon can ſhine and emit their rays, it is by their contact vitiated, and loſing its brightneſs, becomes of a dull colour: thus among many others, the ſecretary Faberius, intending to have his houſe on the Aventine Mount elegantly decorated, had all the walls of the periſtylium coloured with minium; but after thirty days, it changed of various and diſagreeable colours, wherefore he directly ordered other colours to be laid.

But whoever would be more curious, and would have the minium retain its colour, muſt, when the wall is finiſhed and dried, lay over it, with a hog's hair bruſh, a coat of punic wax, melted and tempered with a little oil; then with burning coals in an iron veſſel, thoroughly heat the wall and the wax till it diſſolves and lies even; afterward with a roll of clean linen rub it as they do naked marble ſtatues: this is called cauſtis by the Greeks; and this coat of punic wax will prevent the rays of the ſun and moon from extracting the colour.

(3*) Pliny ſays a ſkin of leather: in pelles fubactus effunditur. See l. 33. ch. 6.

Thoſe laboratories that uſed to be at the mines of Epheſus, are now removed to Rome, becauſe mines of the ſame kind have been ſince diſcovered in Spain, from whence the maſſes of earth are brought, and worked by a public ſociety at Rome: theſe laboratories are between the temples of Flora and Quirinus[1*].

Minium is adulterated with a mixture of lime; whoever therefore would try if it be good, muſt proceed thus: take a plate of iron, and laying the minium thereon, place it on the fire till the plate be red hot; when its bright colour is changed, and it appears dark, take it from the fire, and if, when it is cold, it becomes of its original colour, it is a proof that it is pure; but if it remains of a dark colour, it is a ſign that it is adulterated. I have now mentioned what occurred to me concerning minium. Chryſocolla[2*] is brought from Macedonia, and is dug in thoſe places which are near copper mines; minium and indicum[3*] alſo by their names indicate in what places they are generated.

(1*) Which ſtood on the Quirinal Mount.

(2*) *Chryſocolla, glutium auri. Gold ſolder*, ſo called, becauſe uſed for the ſoldering of gold. Pliny deſcribes it at book 33. ch. 5. He ſays that it was formed by water flowing through the veins of metal being indurated by the cold of winter; and that it was alſo made by art: in that manner it was found in mines of different metal; but that of copper mines was moſt eſteemed. It was called luteum from the herb of that name, with which and alum it was brought to its colour before it could be uſed: this ſubſtance we now call borax; it is brought to us from the Eaſt Indies, and is white: but it is ſaid to take a different colour according to the mine from whence it comes, being yellow if from a gold mine, white from ſilver, black from lead, and green from a copper mine, which latter muſt be that here ſpoken of by Vitruvius, who ſays it was found near copper mines: and at the 14th chapter ſays, wherever it was ſcarce they uſed inſtead of it a mixture of ceruſe and the herb luteum, which made a full green. This Pliny alſo notices, but ſays it is a bad and fallacious colour.

(3*) Minium, from the river Minius in Spain, which, as Galiani obſerves, might have taken its name from the colour, at the time it was found there, rather than the colour from *it*; eſpecially as the colour was firſt diſcovered at Epheſus.

Indicum, from Indicus or India, whence it was brought, according to Pliny, b. 35. ch. 6.

CHAPTER X.

Of factitious Colours, and of Black.

I NOW proceed to ſuch as are made from things of another kind, which, by being wrought, are changed, and acquire the properties of colours; and firſt, I ſhall ſpeak concerning black, of great uſe in all works, that the true manner in which it is prepared and tempered may be known.

A place is built like a laconicum[1*], and lined with marble ſmoothened and poliſhed; before this is built a little furnace, having holes into the laconicum, and the mouth of which is to be very carefully cloſed, that the flames may not paſs outward; then reſin is put into the furnace, the ſmoke from which is, by the fire, forced through the holes into the laconicum, where it adheres to the walls and curve of the dome; whence being collected, part thereof is levigated with gum, to make ink for the uſe of the copyers of books; the reſt is mixed with ſize, and uſed for colouring the ſtucco on walls.

But if theſe materials cannot be procured, that the work may not be delayed, it will be neceſſary to proceed thus: twigs or chips of the pine tree are to be burned, and the coals, when extinguiſhed, are to be pounded in a mortar with glue, which will make a black for the ſtucco work, not diſpleaſing: ſo likewiſe the lees of wine dried and burnt in a furnace, being ground together with glue, and laid on the work, makes an agreeable black; and the better the wine was, from which it was prepared, the black will not only be better, but will even approach the colour of indicum[2*].

(1*) The laconicum is mentioned in the 10th chapter of the 5th book.

(2*) Pliny, b. 35. chap. 6. mentions this black, made from the lees of wine, in the ſame manner; but ſays the moſt eſteemed black was that made from the teda or pine, which was adulterated with the ſoot from furnaces, or the baths: he ſpeaks alſo of the black made of burnt ivory, called elephantinum, and of ſome earths which are naturally black.

CHAPTER XI.

Of Ceruleum and Uſta.

THE making of ceruleum[1*] was firſt diſcovered at Alexandria, but was afterward made by Veſtorius of Puteoli: the manner in which it is made is curious enough; ſand together with flowers of nitre are pounded till they become like powder, which being mixed with the groſs filings of Cyprian copper, is wetted ſo that it may adhere together; then it is rolled into balls, with the hands, and left to dry; theſe, when dry, are put into an earthen veſſel, and ſet in a furnace, where the copper and ſand heating together, and giving and receiving the vapours of each other, change their properties, and by the force of the fire are brought to the colour of ceruleum.

Uſta,[2*] which is very uſeful in ſtucco work, is thus made: the glebe of good ſil is burnt in the fire till it becomes red-hot, and is then quenched in vinegar, which renders it of a purple colour.

(1*) Pliny, b. 33. ch. 13. ſays ceruleum is a ſand, and diſtinguiſhes three kinds of it which were formerly in uſe, viz. the Egyptian, Scythian and Cyprian; to which he adds the Puteolan and Spaniſh, and another ſort latterly introduced, called Veſtorianum, from the inventor: he adds, it is tinged with the juice of an herb in the ſame manner as chryſocolla, and is counterfeited by boiling violets in water, ſtraining the liquor through a cloth, and then mixing it with eretrian earth.

The ceruleum of the antients is thought to be the ſame as, or ſimilar to, that ſubſtance which we call ſmalt, of a blue or azure colour.

(2*) Uſta, which ſignifies burnt, Pliny, b. 35. ch. 6. ſays, was firſt diſcovered by an accidental fire at Pyræus, which by burning ceruſe that was there in earthen veſſels produced that colour; the beſt came from Aſia, and was called purpura: this ſeems to be the ſame as our minium, or red lead. But Pliny adds, uſta was alſo made at Rome, by burning the ſort of ſil called marmoroſum, and quenching it in vinegar (as Vitruvius relates), and that it was uſed for the ſhades of pictures.

CHAPTER XII.

Of Ceruſe, Ærugo and Sandarac.

IT is not foreign to the purpoſe to mention how ceruſe[1*] and ærugo, which we call eruca, are prepared.

The Rhodians place twigs in tubs, wherein they pour vinegar; upon the twigs they lay maſſes of lead, and then cloſe the tubs with covers, ſo that the vapours may not exhale: after a certain time they are opened, and the maſſes of lead are found to be changed to ceruſe.

In the ſame manner laying plates of copper, they become ærugo[2*], which is called eruca.

But ceruſe, when burnt in a furnace, changes colour by means of the fire, and becomes like ſandarac[3*]; which effect men learnt by an accidental fire[4*]; and this is much better for uſe than even that which grows, and is dug from the mine[5*].

(1*) Ceruſe or white lead is well known to be lead, corroded by an acid vapour; vinegar is generally uſed for that purpoſe, by which the lead is corroded and changed to a white ſubſtance. Pliny, b. 34. ch. 17. mentions its being made in the ſame manner.

(2*) Ærugo, or copper ruſt, is by us called verdigriſe; it is of a green or bluiſh green colour. Pliny, b. 34. ch. 11. agrees with Vitruvius in the manner of its being made; he adds, it is ſometimes adulterated with marble duſt, pumice-ſtone, or gum, and with atramentum, or copperas; the former of which may be diſcovered by grinding it between the teeth, the latter by burning it in an iron pan; for if it be pure it retains its colour, if not it turns red.

(3*) *Efficitur ſandaracha* I have tranſlated, *becomes like ſandarac*, meaning like it in colour. The words might be underſtood to ſignify that ceruſe is changed into real ſandarac, which I believe is not the fact, the real ſort being, in my opinion, a compoſition of arſenic and ſulphur, like auripigmentum, with which it is mentioned at the 7th chapter foregoing.

(4*) Pliny, b. 35. ch. 6. relates, that it was uſta that was diſcovered by an accidental fire, as noticed in the foregoing chapter; but it is probable both uſta and ſandarac were diſcovered by the ſame means, both of them being ceruſe burnt in different degrees, or being imitable by ſuch means.

(5*) I muſt here notice what appears to me an error in Galiani's tranſlation. Vitruvius having ſaid that "ceruſe burnt becomes ſandarac," adds, "and this is better for uſe than that which is natural, or which grows in the mine." Galiani in his notes upon this paſſage, ſays, "I bianchi minerali che qui non ſi ſpecificano ſono il melino e il paretonio."—"The white minerals not here ſpecified are melinum and paretonium."

This ſeems to me an evident miſtake, for Vitruvius in this paſſage is not ſpeaking of any white ſubſtances, but of artificial ſandarac; and therefore the unſpecified natural ſubſtance referred to by the words *that which grows naturally*, cannot be any naturally white earths, but the native ſandarac which he has deſcribed at the 7th chapter preceding.

CHAPTER XIII.

Of Oſtrum.

I BEGIN now to ſpeak of oſtrum,[1*] which is the deareſt and moſt excellent of all colours, and has a moſt pleaſing appearance. This is obtained from the ſea ſhell-fiſh, with which the purple dye is made, and which is not leſs worthy of admiration than any other natural curioſity. It is not of the ſame colour in all places where it is produced, but is naturally varied by the ſituation of the ſun. Such as are gathered near Pontus and Gaul, thoſe countries being northerly, are blackiſh. Between the ſouthern and weſtern countries they are found livid. Thoſe toward the Equinoctial, eaſt and weſt, have a violet colour. But ſuch as are taken from the ſouthern regions, are of a ruddy hue. Thoſe therefore which are produced near the iſland of Rhodes, and in other ſimilar places, which are near the line of the ſun, are red. When theſe conchylia are collected, they are broken to pieces with irons, and the purple humour that oozes out like tears, is drained into a mortar, and ground: this is called oſtrum, becauſe it is obtained from ſhell-fiſh; but this, by reaſon of its ſaltneſs, ſoon becomes dry, unleſs it be mingled with honey.

(1*) This is the celebrated purple of the antients, the preparation of which is now entirely loſt, and the ſhell-fiſh, from which it was obtained, unknown to the moderns. It is called alſo by the names of murex, conchylium, and purpuriſſum.

Pliny, b. 9. ch. 36. gives a deſcription of the fiſh and the manner of preparing the colour: its hue, he ſays, is like that of purple roſes; he diſtinguiſhes the conchylium as yielding a colour more dull and inclining to blue. Vitruvius ſays this is the deareſt of all colours; and Pliny, at b. 35. ch. 6. mentions purpuriſſum alſo, as the deareſt of all colours, deſcribing it to be a cretaceous earth, ſaturated with a purple juice; and prefers the Puteolan to the Tyrian, Getulian, or Laconican, becauſe it is firſt dyed with hyſginum, and then with the juice of rubia.

But Vitruvius in the following chapter ſays that that was the method uſed in making a factitious kind of purple. To reconcile theſe two authors therefore, we muſt ſuppoſe that the juice of the fiſh was not uſed alone, but was generally combined with this cretaceous earth, and which might in ſome caſes be previouſly dyed with the juice of rubia and hyſginum, to render the colour more rich or vivid.

In Hawkeſworth's Account of the Voyage round the World by Captain Cook, mention is made of a kind of ſhell-fiſh, which they took in latitude 12° 14′ north, and longitude 22° 10′ weſt of London, of the ſize of a ſnail, floating in bubbles of a ſlimy matter, upon the ſurface of the ſea; and which upon being touched diſcharged about a tea-ſpoonful of a beautiful purple liquor, that would dye linen cloth. This might anſwer the purpoſe of that of the antients, though it does not ſeem to be the ſame fiſh, not agreeing with the deſcription given by Pliny.

CHAPTER XIV.

Of other factitious Colours.

OTHER purple colours are alſo made by tingeing cretaceous earths with the juice of the roots of rubia[1*] and with hyſginum[2*], as well as other colours, by the means of flowers. Thus the dyers, when they would imitate the Attic ſil, put dried violets in a veſſel of water, and boil them over the fire; when ready, they pour it in a cloth, and ſqueezing this with the hands, receive the violet-coloured water in a mortar, to which adding the Eretrian earth, and grinding it, they produce the colour of the Attic ſil[3*].

In the ſame manner, preparing vaccinium[4*] and mixing milk therewith, they make a fine purple. Alſo where chryſocolla cannot be procured on account of its dearneſs, they tinge ceruleum with the herb called luteum[5*], which makes a moſt verdant colour. Theſe are called infective colours. Likewiſe when indicum is wanting; with ſelinuſian or anu-

(1*) Rubia is that plant we call madder.

(2*) It is not certainly known what is meant by hyſginum; but as Vitruvius ſays it was uſed in conjunction with rubia (which gives a red tinge) for making a purple colour, it muſt be ſuppoſed that it yielded a blue colour, and is thought to be the plant we now call woad.

(3*) Pliny, b. 33. ch. 13. ſays, they imitated ceruleum in this manner, as noticed at the 11th chap. foregoing. The Attic ſil is generally allowed to be of a yellow colour, and to be that which we call yellow ochre; for Pliny obſerves that it was uſed for the light parts of pictures, and alſo, that being burnt, it became of the colour of preſſum or Syric ſil, which he deſcribes to be of a ruddy hue, as yellow ochre when burnt becomes.

If then the Attic ſil be yellow, and ceruleum blue, how the ſame preparation, of the juice of violets and the white Eretrian earth, ſhould imitate thoſe different coloured ſubſtances, is difficult to be accounted for, otherwiſe than by ſuppoſing that the violets uſed in the two different proceſſes were of different ſorts and hues. This indeed may have been the caſe; for it is thought the antients included by that name ſeveral ſorts of flowers, to which the moderns give other names; and Pliny, b. 21. ch. 6. deſcribes three ſorts of violets, the purple, the *yellow*, and the white.

The Eretrian earth, Pliny, b. 35. ch. 16. ſays, is of two ſorts, white and grey, and that it took its name from Eretria, a city of Eubœa; and that a line drawn therewith on copper, appears of a violet colour.

(4*) Vaccinium is alſo unknown; ſome have ſuppoſed it to be the privet, others the blackberry: Perrault thinks it to be the glaſtum or woad; and Galiani, the hyacinth: Dioſcorides ſays it produces a purple flower.

(5*) Luteum, or lutum, is the plant *weld*, which affords a yellow tinge; this being mixed with the blue of ceruleum, makes a green, which is the colour of chryſocolla, as obſerved at ch. ix. foregoing.

larian chalk and glaſs, which the Greeks call *yalon*, they make an imitation of the colour indicum.[6*]

In this book I have written what I could recollect concerning the colours for painting, how they ought to be uſed to be durable, and of their reſpective qualities. In ſeven books, therefore, are contained all the rules relative to the perfection and convenience of buildings. In the following I ſhall diſcourſe concerning water, how it may be found, and conducted to the places where it may be wanted, and how to try whether it be good and wholeſome.

(6*) Pliny, b, 35. ch. 6. relates the ſame manner of imitating indicum, which he ſays appears black when pounded, but when diluted, it partakes of the colours of purple and ceruleum: this colour is proved by burning it; for if it be pure, it yields a purple flame, and the ſmoke ſmells like the ſea. Anularia, he ſays, is white, and is made of chalk, mixed with the glaſſy gems from the *rings* of the common people, whence it was called *anularia*.

The ſelinuſian earth, he ſays, b. 35. ch. 16. is of the colour of milk, and eaſily diſſolves in water; mixed with milk, it is uſed to whiten plaſtering.

Vitruvius mentions armenium at the 5th chapter foregoing, but has not deſcribed it. It may not therefore be improper to give Pliny's account of it. At book 35. ch. 6. he ſays, "Armenium is a ſtone which comes from "Armenia, is ſtained in the ſame manner as chryſocolla, "and partakes of the colour of ceruleum, but is a little "lighter."

The Armenian ſtone is now found in Germany, is of a fine blue colour, and differs very little from lapis lazuli, of which the moderns make that excellent blue colour, called ultramarine; except that the former, inſtead of being ſpotted with gold, as the latter is, has ſpecks of a green colour.

END OF THE SEVENTH BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE EIGHTH.

PROEM.

THALES the Mileſian maintained that water was the principle of all things; and Heraclitus, fire; the prieſts of the Magi, water and fire; Euripides, a diſciple of Anaxagoras, whom the Athenians call the ſcenic philoſopher, air and earth, which latter being impregnated by the rain from the heavens, produced men, and all other animals in the world; and as from this they originate, ſo, when they are diſſolved by the courſe of time, they return thereto again: thoſe alſo which are produced from air, return to the region of air, nor can they be annihilated; but being only transformed by their diſſolution, they revert to the ſame ſtate in which they before exiſted.

But Pythagoras, Empedocles, Epicharmus and other naturaliſts and philoſophers, affirm that there are four principles, air, fire, water and earth; and that the union of theſe, by their natural configuration, produces the qualities of the different kinds of things. We may obſerve alſo, that all things are not only produced thereby, but that without their aid, they cannot be nouriſhed, nor grow, nor be preſerved: for the body cannot exiſt without an abundance of air, the influx of which occaſions the continual inſpiration and expiration; nor without a due proportion of heat in the body, will the mind maintain a due firmneſs, or the food be properly digeſted: ſo alſo if the members of the body be not nouriſhed by the fruits of the

earth, they become weak, becauſe they are deprived of the mixture of the element of earth; and if animals were without water, they would become languid and withered, from the want of that element.

The divine Mind therefore has not made thoſe things which are neceſſary to mankind ſcarce and difficult to be obtained, as are pearls, gold, ſilver, &c. which neither the body nor nature require; but thoſe without which the lives of mortals could not be preſerved are placed ready at hand throughout the whole earth: thus, the body requires good air; the air deſtined to that purpoſe affords it the heat of the ſun and of culinary fire, which give warmth, and render life more comfortable. The produce of the earth affording a ſuperabundance of food, ſupports and nouriſhes the animals continually feeding thereon; and water not only for drink, but for a number of other neceſſary purpoſes, as agreeable as it is plentiful, ſupplies our wants: wherefore the prieſts, who perform the rites of the Ægyptians, teach, that all things conſiſt of water; and when they cover the vaſe of water, which is conveyed to the temple with great devotion, they proſtrate themſelves on the earth, and with hands raiſed toward heaven, return thanks to the divine goodneſs for its production.

CHAPTER I.

Of the Manner of finding Water.

As therefore it is thought by naturaliſts, philoſophers and prieſts, that all things conſiſt of water; and as in the foregoing ſeven books, the principles of building are explained, I think it proper in this book to write of the means to be uſed in finding water; the qualities it may have from the different natures of places; in what manner it may be conducted, and how it may be tried, it being ſo highly neceſſary for our exiſtence, as well as pleaſure and daily uſe.

If there be open running ſprings, the work is eaſy; but if not, it muſt be ſought where it is collected under the earth, which may be done thus: before ſun-riſe, lying proſtrate on the place where it is required, and fixing the chin on the earth, look forward, for the chin being

fixed, prevents the ſight from wandering higher than is needful, and confines it to the level of the place; then in thoſe parts where vapours are ſeen gathering and riſing into the air, there dig, for this ſign cannot be in dry places.

In ſeeking for water, the nature of places is to be conſidered; for there are ſome in which it is collected: in clay it is in little quantities, ſhallow, and not of the beſt taſte; in looſe ſand alſo there is but little. If it be found in low places, it will be muddy and ill taſted; but in black earth are found little rills and tricklings, produced by the winter rains, which collect and ſettle in compact and hard ſoils: theſe have the beſt taſte. In gravel there is but a moderate quantity, and the ſprings are not certain, but it alſo is of a good flavour: in the maſculine, common, and carbuncle kinds of ſand, it is certain and conſtant, and is withal of a good taſte: in red ſtone ſoils it is good, and is plenty, if it do not ooze through the pores and waſte: at the bottom of mountains, and among flint-ſtones, it is more copious, and is colder and more wholeſome. The ſalt, groſs, and warm ſprings of the open country, are not good, excepting thoſe from mountains, which, flowing under the earth, break forth again in the plains, and where the ſhelter of trees gives them the agreeableneſs of mountain ſprings. Other ſigns, beſides thoſe above written, of the kinds of earth under which there is water, are theſe: the growing of the ſlender bulruſh, the wild willow, the alder, reeds, ivy, and others of a ſimilar kind, which cannot grow or thrive without humidity; theſe uſually grow near lakes, which being lower than the other parts of the country, receive the rain water and floods of winter, and by their concave form retain the water a long time: but theſe ſigns are not to be truſted to, except in thoſe countries and lands (not in lakes) where they have not been planted, but have naturally grown of themſelves.

In places where there are no ſuch indications, the following experiments are to be made: A hole is dug three feet wide each way, and at leaſt five feet deep, and therein, about the time of ſunſet, is placed a baſon of braſs, or lead, or earth, whichever may be ready: this being anointed with oil on the inſide, is turned upſide downward, and the top of the pit is cloſed with reeds or branches, and then covered with earth; the next day it is opened, and if any drops or moiſture be found in the vaſe, that place has water. Alſo, an earthen veſſel unburnt, being put in this pit, covered in the ſame manner, if the place have water, it will, when uncovered, be found moiſt, and be ſoftened by the humidity. A fleece of wool alſo being laid in the pit, if on the following day water can be preſſed out of it, ſhews that the place has water. So if a lamp, prepared with oil, and lighted, be put in the place, and covered, and the next day be not exhauſted, but ſome of the oil and wick remain, and is wet, it is a ſign the place has water, for heat always draws moiſture to itſelf; and if fire be made in the place, and the heated earth ſends forth cloudy vapours, the place has water.

When theſe experiments have been made, and the above-mentioned ſigns perceived, then a well is to be ſunk on the ſpot; and if a ſpring of water be found, many more may be dug thereabout, and, by means of trenches, the water of all conducted to one place. Theſe ſprings are chiefly to be ſought for on mountains, and on the northern ſides; for in ſuch places they are ſweeter, more wholeſome, and in greater plenty, being averted from the courſe of the ſun; and in thoſe places, the trees and ſhrubs grow in greater abundance; the mountains themſelves, by their ſhadows, preventing the rays of the ſun from ſtriking directly on the earth, and exhaling the moiſture: the valleys alſo among the mountains receive the greater part of the rain, and the herbage is there more abundant: by the ſhades of the trees and the mountains, the ſnow is preſerved a longer time; this melting, drains through the pores of the earth, and runs to the loweſt roots of the mountain, from whence iſſuing, it becomes the ſource of rivers.

On the contrary, in the open country there cannot be much water, or if there ſhould, it cannot be wholeſome; becauſe the heat of the ſun, for want of ſhade, exhales the humidity from the plain fields: and even if water ſhould be apparent, the air attracts and diſſipates in the lighteſt, thinneſt, and moſt ſubtile parts, leaving thoſe which are the heavieſt, hardeſt, and moſt unwholeſome, remaining in the ſpring.

CHAPTER II.

Of Rain Water and its Qualities.

THE water therefore collected from rains is the moſt wholeſome, becauſe it is the lighteſt and moſt ſubtile parts, taken from all receptacles of water; then by the motion of the air it is purified, and being condenſed by the weather, deſcends upon the earth: but it rains not ſo frequently in champaign countries as on mountains, or near mountains; becauſe the vapours that aſcend from the earth in a morning at ſun-riſe, whichever way they incline, thruſt forward the air, impelling the vapours before them, and cauſe the gales and increaſing blaſts of wind.

By the winds, on whatever direction they move, the condenſed vapours riſing from ſprings, rivers, lakes and the ſea, by means of the heat of the ſun are abſorbed, and thus raiſed

aloft in clouds; theſe then floating in the waves of air, when they arrive at mountains, being preſſed by them and the wind, on account of their groſſneſs and denſity, are diſperſed in drops, and ſo deſcend upon the earth.

That vapours, clouds and exhalations, ariſe from the earth, this ſeems to be the reaſon: the earth has within itſelf intenſe heat, much cold air, and great bodies of water; from this, when cooled by the night, vapours iſſue during the darkneſs, and clouds riſe from the damp places; then the riſing ſun ſtriking on the globe of the earth, the air heated thereby raiſes the vapours with the dew: of this the baths afford an example; for ſome of the vaulted ceilings of the Coldaria yield water like ſprings; the air which is there being warmed by the heat of the fire of the furnace, abſorbs the water from the pavement, carries it with itſelf to the ceilings, and there ſuſtains it; for heated air always forces itſelf upward: at firſt it does not deſcend on account of its rarity; but as ſoon as, by the addition of more vapour, it has acquired body, it, on account of its gravity, can no longer be ſupported, but falls in drops on the heads of thoſe who are bathing.

For the ſame reaſons, the air of the atmoſphere, when warmed by the ſun, extracts the moiſture from all places, and gathers it into clouds; for the earth when heated ejects vapours, as the bodies of men when warm emit ſweat. The winds are alſo proofs of theſe things; for thoſe which come from the coldeſt parts, as ſeptentrio and aquilo, blow pure and dry air; but auſter, and others that come from under the courſe of the ſun, are humid, and always bring rain; for being heated by the torrid regions as they come, they imbibe vapours from all the countries in their way, and pour them upon the northern regions.

That this is ſo, is evinced from the ſources of rivers, according as delineated on the map of the earth, and as deſcribed for the moſt part, and generally being found to ariſe in the northern parts: and firſt in India, there are the Ganges and Indus, which ſpring from mount Caucaſus; in Syria, the Tygris and Euphrates[1*]; in Pontus alſo in Aſia, are the Boryſthenes, Hypanis and Tanais[2*]; in Colchis, the Phaſis; in Gaul, the Rhone; and in Belgia, the

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(1*) Theſe rivers are in that part of Aſia called Aſſyria, which, with Cœloſyria, Leucoſyria and Syria proper, were oftentimes included under the general name of Syria.

(2*) Neither of theſe three rivers are now deemed to be in Pontus, or even in Aſia, according to the modern geography, but in Europe, the Boryſthenes being that now called the Nieper; the Hypanis, the Bog; and the Tanaïs, now the Don, dividing Europe and Aſia. Vitruvius however repeats this in two other places, the firſt at the 7th chapter of the 7th book, and again, further on in this chapter.

Pliny alſo, in his Natural Hiſtory, b. 11. chap. 36.

Rhine; ſouthward of the Alps are the Timavus and the Po; in Italy, the Tiber; in Mauruſia, which we call Mauritania, the Dyris, which ſprings from mount Atlas, riſing in the northern parts, and running by the weſt to the lake Eptabolum, where changing its name, it is called the Niger; then from the lake Eptabolum it flows under deſart mountains toward the ſouth, and enters the marſh Coloe, which ſurrounds Meroe in the ſouthern kingdom of Ethiopia; from this marſh, turning by the rivers Aſtaſobam and Aſtaboram, and ſeveral others, it comes through the mountains to the Cataracts, down which precipitating itſelf northernly, it paſſes between Elephantis and Syene, and the Theban fields in Egypt, where it is called the Nile. That the head of the Nile riſes in Mauritania is chiefly known, becauſe on the other ſide of mount Atlas there are alſo ſome heads of rivers which run into the Weſtern Ocean, and in which are bred the ichneumon, the crocodile, and other beaſts and fiſh of a ſimilar kind, as well as the hippopotamos.

As therefore all the great rivers are, according to the map of the earth, found to flow from the north, and the country of Africa, which is in the ſouthern parts, under the courſe of the ſun, has its moiſture concealed within, and has very few ſprings or rivers, it argues that the ſprings which riſe to the north, or north-eaſt, are much the beſt, except they ſhould happen to paſs through ſulphureous, aluminous or bituminous ſoils; for in that caſe they will be changed, and will become warm; or if cold, will have an ill ſmell and taſte; for it is not the natural property of any water to be warm: but when cold water runs through hot ſoils, it effervesces, and, thus heated, iſſues out of the pores of the earth; but it does not long continue warm, but ſoon becomes cold, which were it naturally warm would not happen: the taſte, ſmell and colour, however, are not reſtored, the water on account of the purity of its nature remaining mixed and diſcoloured.

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mentions the river Hypanis being in Pontus: theſe authorities therefore, joined with the conſideration that the antients were well acquainted with that part of the world, favour an opinion that, according to the antient geography, Pontus, and perhaps Aſia, extended ſo far as to include theſe three rivers, differing therein from the modern geography.

CHAPTER III.

Of Spring Water, and its Properties, according to the Minerals it paſſes; and of the Nature of various Springs, Rivers, and Lakes.

THERE are ſome hot ſprings, however, the water of which is of an excellent taſte, and are ſo pleaſant in drinking, that the ſprings of Camœna[1*] or Martia[1*] need not be deſired: theſe are by nature produced in this manner; when, by the means of alum, bitumen, or ſulphur, fire is kindled in the earth, and the ſoil is heated all around, the fervid vapour aſcends to the upper parts, where, if there be any ſprings of pure water, they are heated by the vapour paſſing through the pores, without having their taſte vitiated.

There are alſo ſprings of cold water, of a bad ſmell and taſte; theſe originate in the lower parts, paſs through hot places, and then, running a long courſe under the earth, arrive at the ſurface cold, but with their ſmell, taſte, and colour, vitiated: ſuch is the river Albula on the Tyburtine way[2*], and the cold ſpring in the Ardeatine[3*] lands, having the ſame ſmell as thoſe waters which are called ſulphurati. In other places alſo there are the ſame: theſe, although cold, appear as if they were boiling hot; the reaſon is, that having fallen from on high into places that were in a ſtate of combuſtion, the water and fire meeting together with great violence and noiſe, they have imbibed air, and being thus inflated by the virtue of the compreſſed air, they iſſue bubbling from the ſpring.

Such waters as are not open to the air, but are confined by rocks or other obſtacles, are forced by the power of the air, penetrating through the ſmall pores, to the ſummits of hills; but thoſe who imagine there can be ſprings ſo high as the tops of the hills, when they dig a wide well, find themſelves miſtaken: thus a braſs veſſel, not quite filled, but being two thirds filled with water, and then covered, when heated by the fire, communicates the heat to the

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(1*) The former of theſe ſprings was in a wood near Rome, without the gate of St. Sebaſtian, antiently called Camœna, and afterward Capœna: the latter was one of the aqueducts of Rome, which took its name from the prætor Martius, by whom it was introduced; its ſource was 36 miles from Rome.

(2*) This river is by the road from Rome to Tivoli, and forms the lake now called Solfatara.

(3*) Near Ardea, in the Campagna di Roma: this water, as well as that of the Albula, was formerly uſed for bathing.

water; and this, on account of its natural poroſity, receiving a ſtrong inflation from the heat, not only fills the veſſel, but ſwelling with the ſteam, and raiſing the cover, overflows; yet if, by taking off the cover, the ebullition be expoſed to the open air, it ſubſides again to the ſame place. In the ſame manner, when ſprings are confined by narrow places, the preſſure of the air forces the water upward; but as ſoon as wider apertures are made, having vent by means of the porous quality of the fluid, it ſinks, and returns to its proper level.

All hot ſprings are therefore medicinal; for the water, being boiled with the before-mentioned minerals, acquires qualities uſeful in ſome caſes; the ſulphureous ſprings relieving the diſorders of the nerves, warming and extracting the vitiated humours of the body; the aluminous ſtrengthening the members of the body, when weakened by the palſy or other diſorders, and, through the open pores cheriſhing the frigid parts by the contrary power of heat, relieve, and by repetition reſtore them to their former healthy ſtate: the bituminous are uſed in purging potions, to heal the inward diſorders of the body. There are alſo cold ſprings of a nitrous quality, as thoſe of Pinna, of Veſtina, thoſe of Cutilia, and other places; potions of which purge the body, and paſſing through the inteſtines, diminiſh ſcrophulous tumors. Where gold, ſilver, iron, copper, lead, and other ſimilar ſubſtances, are dug, there are many ſprings, but they are generally noxious, having qualities contrary to thoſe of the warm ſprings, which emit ſulphur, alum, or bitumen, and, when drank, paſſing through the veins, affect the muſcles and joints, hardening and inflating them; ſo that the muſcles being ſwollen, contract in their length, and thus afflict men with the cramp, or the gout; for the veſſels become ſaturated with the hardeſt, groſſeſt, and coldeſt particles.

There is a ſort of water, which, when not cleared enough by the pores, has a ſcum like a flower floating on its ſurface, in colour ſimilar to purple glaſs: this is chiefly obſerved at Athens, where, from ſuch kind of places and ſprings, water is conducted to the reſervoirs of the city, and of the port of Piræus; but, on account of the quality, it is not drank, the inhabitants uſing it only for waſhing and ſuch purpoſes, and, to avoid any ill effects, drink well-water. At Trœzene the inhabitants cannot avoid this evil; for no other kind of water is to be found, unleſs they procure that of Cibdelus: in that city, therefore, all, or the greater part of the people are diſordered in their feet.

At the city of Tarſus, in Cilicia, is a river called Cydnos, in which thoſe who have the gout, ſteeping their legs, are relieved of the pain. There are alſo many other kinds that have peculiar qualities; as the river Himera in Sicily, which, when diſcharged from the ſpring, is divided into two ſtreams: that which runs towards Æthna, paſſing through a ſoil that contains a ſweet juice, is exceedingly ſweet; and the other ſtream, which flows through land from whence they dig ſalt, has a ſaline taſte.

At Parætonium alſo, near the road to Hammon[4*], and from Caſium to Ægypt, there are fenny lakes, which are ſo ſaline, that the ſalt itſelf congeals on their ſurfaces; and in ſeveral other places there are ſprings, rivers, and lakes, which, by paſſing through ſalt mines, have neceſſarily become ſalt: ſome, flowing through unctuous earth, emerge mingled with oil, as the river called Lipar, near Solæ, a town in Cilicia, in which thoſe who ſwim or bathe are anointed by the water itſelf. There is a lake likewiſe in Æthiopia, that anoints the people who ſwim in it; and one in India that emits a great quantity of oil in ſerene weather. At Carthage there is a ſpring, upon which ſwims an oil that ſmells like filings of citron wood; which oil they uſe to anoint their cattle. In Zacynthos, and about Dirrachium and Apollonia, there are ſprings which yield, with the water, a great quantity of pitch.

The vaſt lake at Babylon, which is called *Limne Aſphaltis*, has a liquid bitumen ſwimming upon it; with which bitumen and bricks Semiramis built the walls around Babylon. At Joppa in Syria, and in the Arabia of the Numidians[5*], there are immenſe lakes that emit large maſſes of bitumen, which the inhabitants thereabout collect; nor is this marvellous, for in thoſe places there are many quarries of hard bitumen; the waters therefore, ruſhing through the bituminous ſoil, bring it with them, and when they emerge out of the earth, detach it from them, and eject it. In Cappadocia, in the road that is between Mazaca and Tuana, there is a lake, in which if reeds or other things be in part immerſed, and after a day be taken out, that part which was immerſed will be found petrified, while the other part, which was left out of the water, remains in its original ſtate. So at Hierapolis, in Phrygia, there is a copious ſpring of warm water, which is conducted in trenches around the gardens and vineyards; this in one year forms a cruſt of ſtone, which they take off yearly from the right and left ſides of the trenches, and with it make the partitions of their fields: this happens naturally; for in the country and ſoil where it is produced, there is a juice of a coagulating nature, which, when mixed with, and diſcharged by, the water out of the earth, is, by the heat of the ſun and air, ſuppoſed to be concreted in the manner obſerved in ſalt-pits.

Some ſprings, owing to a bitter juice in the earth, are extremely bitter; as the river Hypanis in Pontus, which for about forty miles from the ſource is of a ſweet taſte; but when it comes to a place that is a hundred and ſixty miles from its mouth, it is mixed with

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(4*) The temple of Jupiter Ammon in Egypt.

(5*) A part of Arabia formerly poſſeſſed by the Numidians, an African people inhabiting the ſhore of the Mediterranean Sea, near Algiers.

a very ſmall rivulet, which, flowing into it, cauſes ſo large a river to be bitter: for this rivulet paſſing through that kind of earth from whence ſandarac is dug, is thereby rendered bitter. Theſe different taſtes are cauſed by the nature of the ſoil, as is obſerved in fruits; for if the roots of trees, vines, or other plants, produced not the fruits with the juices they receive from the earth, they muſt have the ſame taſte in all places and countries: but it is found otherwiſe; for in the iſle of Leſbos is the wine call *protyrum*; in Mæonia, that called *catacecaumeniten*; in Lydia, the meliton; in Sicily, the mamertinum; in the Campania, the phalernum; in Terracina and Fundi, the cæcubum; and in innumerable other places many kinds of wine of different properties are produced, which could not happen, unleſs the juices of the earth infuſed their peculiar qualities into the roots that nouriſh the ſtem, and thence aſcend to the ſummit, giving the ſeveral kinds of fruits a taſte peculiar to the place: and if the juices of the earth were not different and diſſimilar, then not only in Syria and Arabia would the reeds, bulruſhes, and all the herbs, be odoriferous, and the trees yield frankincenſe, pepper, or myrrh; nor would the ferula laſer[6*] grow only in Cyrene; but in all parts of the earth, and in all places the ſame kinds would be produced.

Theſe varieties, in different countries and places, ariſe from the inclination of the earth's axis, and the influence of the ſun, which affects the juices of the earth, according to their proximity to, or diſtance from, its courſe: and theſe various qualities are obſerved, not only in fruits, but alſo in ſheep and oxen, which could not be ſo differently affected, if the properties of the ſeveral countries of the earth were not influenced by the power of the ſun; for the rivers Cephiſus and Cratis, in Lucania; the Xanthus at Troy; and the ſprings and rivers in the Clazomenean, Erythrean, and Laodicean fields, cauſe the ſheep that, in their breeding time, are daily driven to drink thereof (notwithſtanding they may be white), to produce their young, in ſome places ſpotted, in others of a brown colour, and in others black, the water, when in the body, communicating thereto its own peculiar qualities: becauſe, therefore, the oxen that are bred near a river in the Trojan lands are of a yellowiſh colour, and the ſheep are ſpotted therewith and white, that river is by the Trojans called Xanthus[7*].

Some kinds of water, by receiving a poiſonous juice from the earth through which they run, are mortal; as the ſpring of Terracina, called Neptunius, of which whoever is ſo imprudent as to drink is deprived of life: for this reaſon, it is ſaid, the antients ſtopped it up. The lake near Cychros, in Thracia, by which not only thoſe who drink, but alſo thoſe who

(6*) Suppoſed to be benzoin, or elſe aſafœtida.

(7*) Which in Greek ſignifies a yellow or orange colour. This river is alſo called the Scamander.

bathe in it, are killed. In Theſſaly is a ſpring that the cattle will never taſte, nor will beaſts of any kind approach: near which ſpring is a tree bearing purple flowers. In Macedonia, likewiſe, at the place where Euripides was buried, two rivulets concur, paſſing on the right and left of the monument: near one, travellers, invited by the goodneſs of the water, are accuſtomed to repoſe themſelves and dine: but the rivulet which is on the other ſide of the monument nobody approaches, becauſe the water is ſaid to be poiſonous.

In Arcadia is a part of the country named *Nonacris*, in the mountains of which are ſtones from whence diſtils an extremely cold water, called *Stygos Hydor* (water of Styx, or ſorrow); which neither ſilver, braſs, or iron veſſels, can contain, for it penetrates through them, and is waſted: nor can any thing contain it but the hoof of a mule. It is related, that Antipater ſent ſome of this water, by his ſon Iollas, to the province where Alexander was, and with it that king was poiſoned. In the kingdom of Cottus in the Alps, is a water, which whoever taſtes immediately dies. In Campus Cornetus, on the Faliſcan land, by the Campanian way, is a grove, where iſſues a ſpring, in which are ſeen the bones of adders, lizards, and others of the ſerpent kind.

Some ſprings are of an acid taſte; as thoſe at Lynceſtes, at Virena[8*] in Italy, at Theano in the Campania, and at many other places; potions of which have the quality of diſſolving the ſtones that form in the bladder of the human body: this may naturally happen; for there is a ſharp and acid juice in the earth, by which the water is rendered acrid; ſo that when in the body, it diſſolves thoſe concretions that ariſe from the ſediments of liquids, and cauſe the pain. That acids will diſſolve theſe things, may be known from this inſtance: an egg being laid in vinegar a long time, its ſhell will be ſoftened, and diſſolved. Lead alſo, which is ſo tough and heavy, being put in a vaſe with vinegar, and cloſe covered, will be diſſolved, and converted to ceruſe. By the ſame means, braſs, which is of a yet harder nature, is corroded and turned to verdigriſe. Pearls, and even flints, which neither iron or fire by itſelf can affect, being, when heated, ſprinkled with vinegar, will break, and be diſſolved. As theſe effects, therefore, happen before our eyes, we may reaſonably judge that acids, on account of their acrimony, may alſo by a ſimilar operation diſſolve the calculous concretions in the body.

Some ſprings there are that ſeem as if they were mixed with wine; as one in Paphlagonia, which, without wine, intoxicates thoſe who drink it. At Equicula in Italy, and among the

(8*) This is generally allowed by the commentators to be an error, and is, from Budeus, corrected to Velino, ſuch a place being known and mentioned by Pliny; whereas Virena in Italy is not known.

nations of the Medulli in the Alps, is a kind of water that cauſes the throats of thoſe who drink it to be ſwollen. In Arcadia is Clitor, a city not unknown, in whoſe territories there is a cavern, from whence iſſues water that makes thoſe who drink of it diſlike wine. At this ſpring a Greek epigram is inſcribed on a ſtone, expreſſing that it is not proper to bathe therein, it being inimical to the vine; for at this ſpring Melampus, by ſacrificial bathings, cured of inſanity the daughters of Prœtus, and reſtored the minds of thoſe virgins to their former ſtate. The epigram is the following:

O! ſhepherd! who com'ſt hither with thy flock
To Clitor's confines, preſt with noontide thirſt,
Drink of this ſpring thou mayſt, and all around
Theſe Naiad nymphs, thy ſhaggy herd may reſt:
But bathe thee not therein, wouldſt thou eſcape
The ills its fumes intoxicating cauſe.
Flee this wine-hating fountain, where Melampus
Bath'd and expurg'd the raving Prœtides
From ev'ry latent taint; when erſt he came
From Argos to theſe wild Arcadian hills.

In the iſland of Chios is a ſpring that makes thoſe who unawares drink of it fooliſh; and here is engraven an epigram, ſignifying that the water is pleaſant to the taſte, but whoever drinks of it will have the ſenſe of a ſtone. The verſes are theſe:

Sweet the cool drops, theſe bubbling waves diſpenſe,
But he who drinks will be a ſtone in ſenſe.

At Suſa in the kingdom of Perſia, is a little ſpring which cauſes thoſe who drink of it to loſe their teeth: here alſo an epigram is written, ſignifying that the water is proper for bathing; but if it be drank, it will extract the teeth from their ſockets. The verſes of the epigram are,

Behold! O paſſenger, this dreadful ſpring!
Thy limbs therein ſecurely mayſt thou bathe;
But if the water thou preſum'ſt to drink,
So ſoon as it ſhall meet the pouting lips,
Straight to the ground the maſticating teeth
Fall, and forſaken leave their vacant ſockets.9*

(9*) In De Laet's edition of Vitruvius, it is aſſerted, that theſe epigrams were wanting in all the copies of Vitruvius, till they were reſtored thereto from the writings of Iſigonus; I have however ſeen them in two very antient manuſcripts of Vitruvius, in the Britiſh Muſeum.

Several of the ſprings, here mentioned by Vitruvius, are alſo mentioned by Pliny, l. 31. c. 2. Of that at Clitor, both authors, as well as Ovid and others, ſay, that the drinking of it cauſed a diſguſt to wine; whereas, the Greek epigram itſelf expreſſes that it was bathing in it which produced that effect, and that it might be ſafely drank.

CHAPTER IV.

Of the Properties of ſome other Springs and Countries.

THERE are ſome ſprings which cauſe thoſe who are born near them to have excellent voices for ſinging, as at Tharſus in Magneſia, and at other places. Zama is a city of Africa, which king Juba ſurrounded with a double wall, and there fixed his reſidence. Twenty miles from this, is the town of Iſmuc, whoſe territories have an incredible extent: here, although Africa is the parent and nurſe of wild beaſts and ſerpents, in the lands of this town none breed, and if conveyed there they ſoon die: nor does this happen only on the ſpot; for if the ſoil be carried to any other place, it produces the like effect. The ſame kind of earth is ſaid to be alſo in the Balearic iſlands. That country has likewiſe another wonderful quality, which I thus learnt: C. Julius, the ſon of Maſiniſſa, to whom all the lands of the town belonged, was in the army with Cæſar, the father[1*]: he uſed to be my gueſt; and at our daily meals, we occaſionally diſcourſed on philoſophical ſubjects. Talking one time on the virtues and properties of water, he aſſured me, that in that country there were ſprings of ſuch a kind as cauſed thoſe who were there born, to have excellent voices for ſinging; and therefore they always ſent beyond ſea, to procure handſome ſlaves and maidens of a mature age, and married them together, that thoſe who were born of them, might not only have excellent voices, but alſo be handſome in their perſons.

Thus has Nature eſtabliſhed ſo much variety in different things, that even in the human body only, which conſiſts partly of earth, there are many kinds of humours, as the blood, milk, ſweat, urine, and tears: if, therefore, in ſo ſmall a quantity of matter, fluids of ſuch different properties be found, it is no wonder that in the vaſt maſs of the whole earth, there ſhould be an innumerable variety of juices, through which the ſtreams of water running, arrive tinctured therewith at their ſources, and thus the differences of the climate, and different properties of the earth, produce the peculiar qualities of different ſprings.

(1*) See the Obſervations on the Life of Vitruvius.

Of theſe things, ſome I have myſelf ſeen, others I have found written in ſundry Greek books, the authors of which are Theophraſtus, Timœus, Poſidonius, Hegeſias, Herodotus, Ariſtides, and Metrodorus; who with great care and ſtudy have written of the properties of countries, the virtues of waters, and qualities of different regions, ariſing from their different climates. From theſe I have taken, and written, in this book, ſo much on the varieties of water as I thought ſufficient; that men may by theſe rules readily chooſe proper water to be conducted for uſe to the fountains of cities and municipal towns. For of all things, none are ſo neceſſary as water; the nature of all animals being ſuch, that if they be deprived of corn, yet by the fruit of trees, or fleſh, or fiſh, or by other foods, they may ſupport life; but without water, neither the bodies of animals, nor any kind of food itſelf, can grow, be preſerved, or prepared: wherefore great care and attention is required that ſuch ſprings of water be choſen as are ſalutary to human life.

CHAPTER V.

Of the Means of trying the Goodneſs of Water.

TRIALS and proofs of water may be thus made: If it be a running ſtream, and open, before it is begun to be conducted, the people who live adjacent muſt be obſerved and examined; and if they have ſtrong bodies, are freſh coloured, have not bad legs, nor ſore eyes, it is a proof of the goodneſs of the water. But if it be a new ſpring, let it be ſprinkled in a Corinthian or other vaſe, that is of good metal; and if it make no ſpots, it is good. Alſo if the water be boiled in a cauldron, and when cold, and poured out, no ſand or mud be found at the bottom of the veſſel, it is a mark of its goodneſs. So likewiſe if pulſe, boiled in the water, be quickly cooked, it ſhews the water to be good and wholeſome: and if the water in the ſpring itſelf appear limpid, and clear; and where it paſſes, or runs, neither moſs nor ruſhes grow; nor is the place defiled with any other impurity, but has a clean appearance; theſe are ſigns that the water is pure and ſalubrious.

CHAPTER VI.

Of the Conducting and Levelling of Water; and of the Inſtruments for that Purpoſe.

I SHALL now explain the manner of conducting water to cities and habitations, in doing which, the firſt buſineſs is levelling.

Levelling is performed either by the dioptra, water level, or chorobates; but moſt accurately by the chorobates, becauſe the dioptra and water level are liable to error. The chorobates is a ruler (*A*) about twenty feet long: this has ancons (*B*) at the extremities, made perfectly equal, and joined to the ends of the ruler at right angles; and having, between the rulers and ancons, fixed by tenons, tranſverſe pieces (*C*) which have perpendicular lines marked thereon; and perpendicular pendents (*D*) are ſuſpended from the ruler, one at each end; which, when the ruler is placed, if they equally coincide with the lines deſcribed, ſhew it to be ſituated level: but in caſe the wind ſhould diſturb the ſtrings, ſo that they cannot give a true indication, then having a groove (*E*) in the upper part, five feet long, one digit broad, and a digit and a half deep, water is to be poured therein; and when the water equally touches the upper edge of the groove, it ſhews it to be level; ſo that by the chorobates, when thus levelled, the quantity of the deſcent may be known.[1*]

Fig. LXIII.

(1*) The forms of the dioptra and water level of the antients are now unknown; nor is that of the chorobates to be known with certainty from this deſcription. The idea of it that occurs to me is different from that of the other tranſlators: I do not perceive that the deſcription authoriſes the making it a kind of caſe, or double frame, of timber work; which muſt be very heavy and inconvenient to move. I differ alſo in judging that the ruler, on account of its great length, ſhould be ſituated edgeways, in order to prevent its bending in the middle; which a ruler of 20 feet, if placed flatways, muſt in time do, unleſs made enormouſly thick.

Perrault remarks, that the tranſverſe pieces are ſaid to be put between the ruler and ancons (*inter regulam & ancones a cardinibus compacta tranſverſaria*); and that, as the ruler and ancons join, there cannot be any thing between them; but the word *inter* is ſometimes uſed by Vitruvius to ſignify the ſpace within, and circumcluded by the parts named; as is obſerved at the 21ſt chapter of the 10th book: in the preſent caſe, it evidently muſt have ſuch a meaning; importing that the tranſverſe pieces are ſituated ſomewhere within the ſpace, circumcluded by the ruler and the ancons, or that they in ſome way paſs from one to the other. Theſe reaſons have led me to imagine that the tranſverſaria may join both thoſe members in the manner of braces, CC, Fig. LXIII. ſuch braces being highly uſeful, if not neceſſary, for holding the ancons in their true rectangular poſition, as well as for ſtrengthening the ruler in the middle of its length. In this, however, I pretend not to certainty; it is only an idea, different from the common one, ſubmitted to inveſtigation.

Perhaps thoſe who have read the books of Archimedes, may ſay, that a true level cannot be obtained by water; becauſe he ſuppoſes water not to be level, but to have a ſpheroidal curve, the center of which is in the ſame place with that of the earth: but whether the water be flat or ſpherical, the extremities of the groove of the ruler muſt equally ſuſtain the water; for if one end declines, the water will not touch the upper edge of the groove of the ruler at the higher end; ſo that notwithſtanding the water may have a ſwelling and curvature in the middle, yet the ends on the right and left muſt, with regard to each other, be on a level. The figure of the chorobates will be deſcribed at the end of the book. If the deſcent is great, the eaſier the water may be conducted; but if the interval ſhould be concavous, recourſe muſt be had to ſubſtruction.

CHAPTER VII.

Of the Manner of conducting Water.

DUCTS of water are made of three kinds; channels of maſonry, leaden pipes, or tubes of fictile ware: of which theſe are the rules.

If channels be uſed, they ſhould be as ſolid as poſſible, and the bed of the ſtream ſhould have a deſcent not leſs than half a foot in a hundred feet. They alſo ſhould be arched over, that the ſun's rays may not touch the water. When it arrives at the city, a caſtellum[1*] is built, and a triple emiſſary to receive the water is adjoined to it. In the caſtellum are three pipes equally diſpoſed within the adjoined receptacles, ſo that when there is too much water, it may, from the ſide ones, be diſcharged into the middle receptacle. Then in the middle one, are fixed the pipes leading to all the ciſterns and fountains; in another, thoſe to the baths, which pay to the people a yearly tribute; and in the third, thoſe to private houſes, if it be not wanted for public uſe: for they could not return it, if they might have peculiar ducts from the ſpring head. The reaſon why this diſpoſition is eſtabliſhed, is, becauſe by

(1*) The receptacle, or reſervoir, was called *caſtellum*, the ruins of ſeveral of which ſtill remain in and near Rome.

the tax on thoſe which are carried to private houſes, the public officers keep the aqueducts in repair.

But if there ſhould happen to be mountains between the city and the ſpring head, the work muſt be thus ordered: A ſubterraneous paſſage is to be dug through the earth, having the deſcent before written; then if the ſoil be either gravel, or ſtone, a channel is to be cut therein; but if it ſhould be earthy, or ſandy, walls, with arches, are to be built in the paſſage, and by that means the water conducted. Wells[2*] alſo are to be there made, ſo that between every two there may be an actus.[3*]

If the water be conducted by leaden pipes, a caſtellum is firſt built at the ſpring head: then, the lamina of the pipes being ſuited to the quantity of water, theſe pipes are laid from this caſtellum to that which is in the city. The pipes ſhould not be leſs than ten feet in length, each of which, if they be centenariæ, ſhould weigh 1200 pounds; if octogenariæ, 960 pounds; if quinquagenariæ, 600 pounds; quadragenariæ, 480 pounds; tricenariæ, 360 pounds; vicenariæ, 240 pounds; quinumdenæ, 180 pounds; denæ, 120 pounds; octonæ, 96 pounds; and quinariæ, 60 pounds. For from the number of digits contained in the breadth of the lamina before it be bent round, the pipes receive their names: thus, when a lamina contains fifty digits, the pipe that is made with it is called quinquagenaria; and ſo of the reſt.

This manner of conducting water by pipes of lead is thus regulated: If the ſpring head have a ſufficient current to the city, and there be no higher mountains between, that may be an impediment, the interval is, by walling, raiſed to the proper level, as mentioned in the deſcription of channels of maſonry; or elſe a circuit round may be taken, if not very long: but if there be frequent valleys, the courſes are to be directed down the declivities, and when ar-

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(2*) Putei is the word of the text, here rendered wells; they are ſuppoſed to be air-holes, cut through from the top of the mountain to the ſubterraneous paſſage, for the purpoſe of giving vent to wind, or vapours which may ariſe from the water.

(3*) An actus is an hundred and twenty feet. Perrault and Galiani, thinking the diſtance of an actus between the wells to be leſs than is neceſſary, ſuppoſe that the number is, by miſtake, omitted after the word actus, the rather as the text has *ſint actus*, where, if it were ſingular, it ſhould have been written *ſit actus*. Upon examining five manuſcripts, I found they all agreed in having *ſit actus*, not *ſint*, as in the printed editions: and one in the Vatican, here quoted by Galiani, has alſo the ſame reading; ſo that it ſeems probable, one actus only is to be underſtood; notwithſtanding, the wells may be, in this caſe, nearer together than ſeems to us neceſſary.

rived at the bottom, a ſubſtructure is to be built, but not high, that the libramentum[4*] may be as long as poſſible. This will be the venter, which the Greeks call *koilian*. When arrived at the oppoſite declivity, as, on account of the length of the venter, it (the water) ſwells gently, it is preſſed upward to the top of the aſcent; whereas, if a venter ſhould not be made in the valley, nor a ſubſtructure built level, but ſhould be bent, the joints of the pipes would be broken and deſtroyed. In the venter, alſo, columnariæ[5*] are to be raiſed, through which the force of the vapours may be diſſipated: thus, thoſe who would conduct water by leaden pipes, may by theſe rules eaſily execute the decurſions, circumductions, venters, and expreſſures[6*].

It will alſo not be unuſeful, when the level from the ſpring head to the city is obtained, to erect a caſtellum at every two hundred actus[7*] diſtance, that if damage ſhould happen at any place, the whole work need not be taken down, and that the defective place may be the eaſier found; but theſe caſtellums ſhould be built, neither in the decurſions, nor in the plane of the venter, nor in the expreſſures, nor in any of the valleys, but always on the even plane.

(4*) The general ſignification of this word is that of level, counterpoiſe, balance, weight, &c. Vitruvius ſometimes uſes it to expreſs that declination from the exact level which is neceſſary to give a proper current to the water. It ſeems here to ſignify all that part of the aqueduct which paſſes down the declivity.

(5*) The columnariæ are probably vent pipes; for Vitruvius ſays they are to give vent to the vapours that may be confined with the water in the pipes; a precaution he has ſeveral times before mentioned. Their names induce a belief that they were perpendicular tubes, like columns, which, being always open at the top, muſt have been ſo high, that their tops might be above the level of the aqueduct; for otherwiſe the water, always preſerving its level, would run out at theſe vents, inſtead of paſſing along the aqueduct.

(6*) By this word, which is written *expreſſus* in the text, is probably to be underſtood that part of the aqueduct where the water riſes, or is raiſed, upward by the weight or preſſure of the deſcending water. For Vitruvius has mentioned no other preſſure or power made uſe of for raiſing the water, nor indeed is any other power neceſſary in theſe caſes, where the water, being incloſed in pipes, will naturally riſe again to the ſame height from which it deſcended.

This chapter may ſerve to remove that erroneous notion which ſome people have conceived, viz. that the antients were ignorant that water confined in tubes will riſe again to the ſame level from which it deſcended, and which they infer from conſidering the great expence, labour, and time, their walled aqueducts muſt have coſt, when the end might have been anſwered ſo much eaſier and cheaper by any kind of pipes. It is here ſufficiently evinced that the antients were well acquainted with this property of water, and that they ſometimes made uſe of it. Pliny, b. 31. ch. 6. alſo expreſsly mentions it.

Health was probably the motive for preferring the walled aqueducts, and for avoiding leaden pipes. Vitruvius mentions hereafter that the water paſſing through ſuch pipes was not deemed wholeſome, on account of its imbibing ſome particles of the lead: and though this objection will not be valid againſt earthen tubes, yet they might not be conſidered as ſufficiently ſubſtantial, and even capacious, to be depended on for ſupplying a great city with the rivers of water daily uſed and waſted; eſpecially in caſes where the water was to be brought from places many miles diſtant.

(7*) If an actus is to be reckoned 120 feet, then 200 actus will equal 24,000 feet. Galiani has written 4000 feet, omitting 20,000, I ſuppoſe by miſtake, and it is not corrected in the errori.

But if it be required to conduct water with leſs expence, it muſt be done thus: Tubes of earthen ware are made, having coats not leſs than two inches thick; and theſe tubes are ſo made, that one end being tongued, the one may enter the other; then the joints are cemented with quicklime tempered with oil; and in the deſcents level with the venter, a ſtone of the red kind is placed at the angles, ſo perforated, that the laſt tube of the decurſus, and firſt on the plane of the venter, may be joined to the ſtone. So likewiſe at the oppoſite acclivity, the laſt in the plane of the venter, and the firſt of the expreſſure, are to be in the ſame manner united to the red ſtone.

Thus the tubes on the even plane, as well as thoſe in the decurſus and expreſſure, will not be ruptured; for ſuch violent vapours are apt to ariſe in conduits of water as would even burſt through ſtone, unleſs the water was, at firſt, gently and ſparingly admitted from the ſpring, and the bendings ſecured with ligatures, or weights of ballaſt. In all other reſpects they are laid in the ſame manner as leaden pipes. When firſt the water from the ſpring is admitted, aſhes are ſent before it, that if any of the joints ſhould not be ſufficiently cemented, they may be ſtopped by the aſhes.

Aqueducts of tubes have theſe advantages: firſt, with regard to the work, if any damage ſhould happen, any perſon may rectify it; and then alſo, the water from earthen tubes is more wholeſome than that from pipes, as lead is found to be pernicious; for from it is made ceruſe, which is ſaid to be hurtful to the human body; and if that which is made from it is noxious, there is no doubt but that itſelf is alſo unwholeſome. This is exemplified by the workers of lead, whoſe bodies are of a pallid colour: for when they are melting the lead, the vapour of it ſettling on their limbs, and the whole day ſcorching them, extracts from the members the juices of the blood. We therefore ſhould not conduct water in pipes of lead, if we would have it wholeſome; the taſte alſo of that from tubes is better, as is proved at our daily meals; for all perſons, although they have tables furniſhed with vaſes of ſilver, yet uſe fictile ware on account of the purity of the taſte.

But if there be no ſpring from whence we may make an aqueduct, it is neceſſary to dig wells; and in digging of wells, reaſon is not to be diſregarded, but the nature of things is with great attention and judgment to be conſidered. For the earth generates in itſelf many and various ſubſtances; it is in fact, like other things, compoſed of the four elements; and the firſt is itſelf, earth; from moiſture it has ſprings of water; alſo heat; from whence come ſulphur, alum, and bitumen: and air, whence the prodigious vapours, which, when condenſed, pierce through the interſtices of the earth to the apertures of wells, and diſturb the men who may be there digging, obſtructing, by the natural vapour, the breath of their noſtrils; ſo that whoever does not ſpeedily fly, there dies. The means by which this is to

be avoided are theſe: A lighted lamp is to be let down; and if it remain burning, you may deſcend without danger; but if it be extinguiſhed by the ſtrength of the vapour, then adjoining the well, on the right and left, æſtuaria[8*] are to be dug, that the vapour may be diſſipated through the æſtuaria, as through noſtrils. When this has been done, and the water obtained, then the well may be encompaſſed with a wall, in ſuch a manner as not to obſtruct the ſpring.

But if the place ſhould be hard, or no ſpring ſhould be found at the bottom, then by the means of ſignine work, the water from roofs, or high places, muſt be preſerved. In ſignine works theſe rules are to be obſerved: firſt, the pureſt and rougheſt ſand is to be provided; the cementum muſt be of flint ſtones broken, ſo as not to weigh more than a pound; and the lime muſt be the moſt ardent. It is ſo mixed in the pit, that five parts of ſand may correſpond to two of lime: the cementum is to be added in the pit[9*]: with this the walls of the well, as low as it is ſunk, are, by the help of wooden levers armed with iron, to be plaſtered. The walls being plaſtered, the earth that may be in the middle is to be taken out quite to the bottom of the walls, and the ground being levelled, the pavement is to be laid with the ſame mortar, to the thickneſs intended. If theſe places be made duple, or triple, ſo that the water may be filtered in paſſing through them, it will be rendered more wholeſome; for when the mud it may have ſubſides, the water becomes the clearer, and preſerves its taſte untainted: if this be not done, it will be neceſſary to add ſalt, in order to clarify it.

Of the qualities and varieties of water, with its uſes, and the means by which it may be conducted and examined, I have as well as I am able written in this book. The principles of dials and horologia I ſhall deſcribe in the following.

(8*) If theſe æſtuaria were mere holes, the vapour could as well be diſcharged through the mouth of the pit as through them; they might indeed haſten the evaporation, but not ſo much as to be equivalent to the labour and time of digging the holes, or as could be done more ſpeedily by other means at the mouth of the well itſelf.

(9*) Signinum is noticed at b. 2. ch. 4. where I have obſerved that I thought Galiani had miſapprehended this paſſage; but I muſt, in juſtice to Galiani, acknowledge that I was myſelf miſtaken.

Pliny (35. 12.) ſpeaking of Signinum, ſays it was compoſed of lime and the powder of tiles or bricks. At book 7. ch. 4. ſuch a kind of mortar is mentioned by Vitruvius, and directed to be uſed in damp ſituations: the words are *arenato teſta*, which ſignifies a compoſition of lime, ſand, and powder of bricks or tiles. And at b. 5. ch. 11. he ſays, that the ſeats in the xyſti, which were open places, and conſequently liable to be damp, were formed of ſigninum.

The term *ſigninum* is ſuppoſed to be derived from Signia, a town of Italy, where it may have been firſt uſed, or invented.

END OF THE EIGHTH BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE NINTH.

P R O E M.

THE renowned athletæ who conquered in the Olympian, Pythian, Iſthmian, and Nemean games, were ſo highly honoured by the antient Greeks, that they not only in the aſſembly, adorned with palms and crowns, were applauded; but alſo, when they returned victorious to their own cities, they were carried in triumphant quadrigæ[1*] through the fortifications, and all their life enjoyed an eſtabliſhed proviſion from the public. When I conſider this, I wonder that the ſame, or greater honours are not beſtowed on thoſe authors whoſe works are continually ſerviceable to the whole world; for they are more worthy of ſuch inſtitutions, ſince the athletæ render ſtronger by exerciſe their own bodies only; whereas authors improve not only their own minds, but all others, by preparing books and precepts to enlighten the underſtanding. For what advantage accrued to mankind from Milo the Crotoniat being unconquered, or from others who were victors of that kind, except that among their own citizens they themſelves were ennobled during life? But the precepts of Pytha-

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(1*) Chariots drawn by four horſes a-breaſt, for the entrance of which, on theſe occaſions, it is ſaid the city wall was broken through.

goras, Democritus, Plato, Ariſtoteles, and other ſages, being daily and continually inculcated, not only to their own countrymen, but alſo to all other nations, produce new and conſtant edification; and thoſe who in their youth are fully inſtructed in theſe ſciences, become the wiſeſt of men, and teach the citizens the moral virtues, juſtice, and laws, without which no city can ſubſiſt.

As therefore mankind, both privately and publicly, are ſo benefited by the wiſdom of authors, they ſhould be decreed not only palms and crowns, but alſo triumphs, and adjudged worthy to be placed on the ſeats of the Gods. From many of their diſcoveries which are uſeful in human life, I ſhall ſelect a few as examples, that it may be acknowledged ſuch honours ought to be conferred on them by mankind. And firſt, I ſhall give one of the moſt uſeful, out of many of Plato's inventions, as explained by himſelf.

CHAPTER I.

Of Plato's Method of doubling a Square.

1* IF a place or field being ſquare and of equal ſides ſhould be required to be doubled and be ſtill of equal ſides, this, which cannot be done by numbers, may be accurately performed by lines, and it is thus demonſtrated:

The ſquare place being in length and breadth ten feet, contains an area of an hundred feet; if therefore the ſpace be required to be doubled, and to contain two hundred feet, and

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(1*) The three firſt chapters of this book are generally allowed to have been intended by Vitruvius as part of the Proem, and erroneouſly divided into the four chapters by the copyiſt. For in this book Vitruvius enters upon the ſecond of the three parts into which he at the beginning divided Architecture, viz. gnomonics, or dialling, to which the ſubject of the ſaid three chapters have no relation; and his addreſs to Cæſar, at the latter part of the third chapter, and manner of concluding it, contributes to confirm this opinion.

I am alſo perſuaded that the firſt chapter of the firſt book was meant by Vitruvius as the proem (that which is called the proem being rather the dedication, or addreſs to the Emperor); for, like the other proems, it conſiſts of hiſtorical narrations and preparatory diſcourſes; and he does not enter regularly upon the ſubject of Architecture, or begin to explain the art, till he comes to that chapter which is uſually numbered the ſecond.

ſtill be of equal ſides, it is demanded how large each ſide of this ſquare to contain two hundred feet, anſwering to the double of the given area, muſt be made. This cannot be ſolved by numbers; for if 14 be taken and multiplied into itſelf, it produces 196 feet; if 15, 225 feet: as therefore it cannot be found by numbers, in the ſquare (*ABCD*) which is in length and breadth ten feet, the line (*BD*) that extends from angle to angle diagonally, is to be drawn, ſo that it may divide the ſquare into two triangles (*BAD* and *BCD*) of equal magnitude; the area of each being fifty feet: then with the length of this diagonal line (*BD*) another ſquare (*BEFD*) of equal ſides is deſcribed. Thus as the two triangles formed by the diagonal line in the leſſer ſquare contain fifty feet each, the ſame magnitude, and the ſame number of feet, will each of the four triangles (*BAD*, *BAE*, *EAF* and *FAD*) in the greater ſquare contain. This method of doubling (a ſquare) by the means of lines, as here deſcribed, was demonſtrated by Plato.

Fig. LXIV.

CHAPTER II.

Of the Method of Pythagoras, for the Formation of a Right-angled Triangle.

PYTHAGORAS ſhewed how to form a right angle without the inſtruments of artificers; and, although the workmen, with great difficulty, can ſcarcely produce a true rectangle, yet by the rules and methods derived from his precepts, it may be done with facility.

Fig. LXV.

For if three rulers be taken, one of which (*AB*) is three feet, the other (*BC*) four feet, and the third (*CA*) five feet, and theſe rulers be ſo laid together that their ends may touch one another, they will deſcribe the figure of a triangle (*ABC*), and form an exact right angle (at *B*); and if on the length of each of the rulers, a ſquare of equal ſides be deſcribed, the ſquare (*ABDE*) which has ſides of three feet, will contain an area of nine feet; that (*BCFG*) of four feet, ſixteen feet; and that (*CAIH*) of five feet, twenty-five feet; ſo that the number of feet in the areas of the two ſquares (*AD* and *BF*) whoſe ſides are three feet, and four feet in length, become equal to the number in that (*AH*) whoſe ſides are five feet long. When Pythagoras invented this, not doubting but that, in

the diſcovery, he had been aſſiſted by the Muſes, to render them the greater thanks, it is ſaid he offered to them ſacrifices.[1*]

This principle is uſeful in meaſuring, and in many other caſes; it is ſo likewiſe in buildings, for the erection of the ſtaircaſes, that the aſcent of the ſteps may have a moderate inclination; for if the height (*AB*) of the ſtory be divided into three parts, five of theſe will be the juſt length of the inclined ſhafts (*AC*) of the ſtairs; for the height of the ſtory, whatever it may be, being divided into three parts, four (*BC*) is ſet off from the perpendicular (*BA*), and there (at *C*) the interior[2*] footings of the ſhafts are fixed; by this means the diſpoſition of the ſtairs, and the aſcent of the ſteps, will be moderate.[3*]

Fig. LXVI.

(1*) This problem of Pythagoras, as well as that of Plato foregoing, is founded on the 47th propoſition of the firſt book of Euclid, by which it is demonſtrated, that, the ſquare of the hypothenuſe of any right angled triangle is equal to the ſum of the ſquares of the two ſides. The diſcovery of this propoſition is generally aſcribed to Pythagoras, who, it is ſaid, uſually ſacrificed an ox every time he made any diſcovery in geometry, but that on this occaſion he ſacrificed an hecatomb.

(2*) Galiani obſerves that the word *interiores* ſhould be read *inferiores*, or *anteriores*, which appears to me highly probable. I ſhould prefer the former, but have not choſen to differ from the text.

The *interior* would probably mean the *under* ſide of the ſcapi; and in that caſe their upper ends could not abut againſt the floor, but would riſe wholly above it, or at leaſt that part of it from whence the meaſures originate.

(3*) By this means the tread of the ſteps will be to the riſe as 4 to 3, ſo that if the tread be a foot broad, the riſe will be nine inches, which the moderns in general think too much. We now univerſally fix half a foot, or thereabout, as the ſtandard for the riſing of the ſteps in convenient ſtaircaſes; although we often deviate therefrom in particular caſes; and a foot is as generally conſidered as the proper breadth of the tread; ſo that the breadth or tread of our ſteps are to their height or riſe, as 2 to 1, and are therefore much leſs ſteep than thoſe of the antients.

C H A P T E R III.

How the Portion of Silver mixed with Gold in any Work may be diſcovered and aſcertained.

ALTHOUGH the many inventions of Archimedes were wonderful and various, yet this which I ſhall relate, ſeems above all others to indicate his exceeding ingenuity. Hiero being raiſed to the regal power in Syracuſe, reſolved, for the ſucceſs of his actions, to dedicate a votive crown of gold, in ſome temple of the immortal gods. He determined to have it made of great value, and ordered the quantity of gold to be weighed to the workmen; who at the time appointed preſented the work to the king, curiouſly wrought; and the weight of the crown was found to be equal to that of the gold he received. Some time after, however, ſigns appeared, that part of the gold had been embezzled, and that ſo much ſilver had been mixed with the crown in its ſtead. Hiero, offended at this impoſition, and not knowing by what means to detect the fraud, deſired Archimedes to take the matter into conſideration. While he was revolving this in his mind, it happened that he went to the baths, where, when he deſcended into the ſolium[1*], he obſerved, that as much of his body as entered therein, cauſed ſo much of the water to flow out of the ſolium. Struck with this method of ſolving the difficulty, he ſtayed no longer, but, tranſported with joy, leaped out of the ſolium, and running home naked, cryed with a loud voice, he had found what he ſought: for as he ran, he frequently exclaimed in Greek, EURECA, EURECA. Upon this principle, it is ſaid, he made two maſſes, each equal to the weight of the crown, one of gold, and the other of ſilver; this done, he filled a large vaſe with water to the brim, in which he put the maſs of ſilver, whoſe bulk, when ſunk in the vaſe, cauſed a portion of the water to overflow. Then taking out the maſs, he poured in again the quantity, meaſured with a ſextarius, that was requiſite to fill it to the brim, as before; thus he found what quantity of water correſponded to a certain weight of ſilver: this being known, he likewiſe put the maſs of gold into the vaſe thus filled, and taking it out, in the ſame manner meaſured the quantity added, and found that the

(1*) At chapter 10. book 5. Vitruvius calls the baſon that contains the water, *labrum*, where I have obſerved, alſo, that it muſt be of thoſe kinds which are ſunk below the pavement of the room; but this baſon, that is here called *ſolium*, is probably of the ſmaller kind, that ſtood upon the pavement.

quantity of water it had cauſed to overflow was not ſo great; but was as much leſs as the magnitude of the maſs of gold was leſs than that of the ſame weight of ſilver: laſtly, filling again the ſame vaſe with water, he put therein the crown itſelf, and found that more water was diſplaced by the crown, than by the maſs of gold of the ſame weight: ſo that from the water diſplaced by the crown, more than that by the maſs, he diſcovered by calculation the quantity of ſilver mixed with the gold; and thus detected the fraud of the workman.

Let us now transfer our attention to the inventions of Architas the Tarentine, and of Eratoſthenes of Cyrene, who have by their mathematical knowledge made many diſcoveries uſeful to mankind: and although for other inventions they may be applauded, for the ſolution of the following problem they are chiefly celebrated. Each undertook to ſolve, by different methods, the reſponſe uttered by Apollo in Delos, to make an altar like his, but containing double the number of cubic feet; and that, thereafter, thoſe who might be in that iſland ſhould be freed by the religion. This Architas ſolved by the deſcription of the hemicylinder, and Eratoſthenes by the mechaniſm of the meſolabium.[2*]

(2*) The altar of Apollo at Delos was a cube, and the propoſition was to find the meaſure of another cube, whoſe quantity ſhould be exactly double that of the former.

If a cube be formed, whoſe ſide is double that of the given cube, it will contain eight times the cubical quantity, being the fourth number of a geometrical ſeries increaſing in a duplicate ratio, as 1. 2. 4. 8, and of which the cube required is the ſecond number of the ſeries. It is ſaid, that Hippocrates, reflecting upon this principle, reduced the propoſition to the finding two geometric mean proportionals between two given lines, one equal to the ſide of the given cube, and the other, double thereof; the leaſt of which mean proportionals will be the meaſure of the ſide of a cube that ſhall be exactly double in quantity to the given cube.

To find theſe two mean proportions, ſeveral methods were diſcovered by the antients. Architas, Eratoſthenes, Plato, Nicomedes, Apollonius, and others, have invented different methods; but they are all tentative: theſe may be met with in books of geometry, to which I refer the reader. I ſhall, however, here deſcribe the principle on which the mechanical contrivance of Eratoſthenes was founded.

Fig. LXVIII.

Let *AB* and *CD* be the two given lines, drawn parallel to each other; join *AC* and *BD*, draw the line *AF* to any point *F*, and from the point *F* raiſe *FE* parallel to *AB*; then from *E* draw the line *EH* parallel to the former line *AF*, and from *H* raiſe *HG* parallel alſo to *AB*: laſtly, from *G* draw *GD* parallel to the former lines *AF* and *EH*, and if the line *GD* interſects the line *CD* in *D*, the operation is right; if not, the direction of the lines *AF*, *EH*, and *GD*, muſt be altered till it ſo happens; when *EF*, and *GH*, will be the two mean proportionals ſought. This method is founded upon the 4th propoſition of the 6th book of Euclid, which demonſtrates that the correſponding ſides of equiangular triangles are proportionals.

By the ſame proceſs any number of mean proportionals may be found between the two given lines *AB* and *CD*. As every addition to the ſeveral inventions left us by the antients for finding two mean proportionals, may not be without its uſe, I ſhall here annex one that I have diſcovered.

BD, *Fig. LXVIII.* is the longeſt given line, and *DE* is the ſhorteſt, perpendicular to the former: continue *BD* toward *C* indefinitely; alſo draw the perpendicular *BA*

As theſe efforts of the ſciences are regarded with ſo much pleaſure, and we are naturally forced to be pleaſed with ſuch inventions, upon conſidering their ſeveral uſes; ſo on peruſing it, I much admire the book of Democritus upon the nature of things, and his commentary which is inſcribed *Cheirotoneton*; wherein he uſed a ring to ſeal, with red wax, what had been experienced. The ſtudies of ſuch men not only tend to correct the morals of their time, but are alſo calculated to remain a perpetual benefit to mankind; whereas the feats of the athletæ, in a ſhort time, with their bodies, periſh:—ſo that neither while they are living, nor afterwards, nor by their inſtructions, can they produce ſuch advantages to human life as are derived from the ſentiments of the learned. But although due honours are not afforded to authors, for either their knowledge or inſtructions, yet by the ſtrength of their own minds, looking above the world, in the memory of ſucceeding ages they are exalted to the heavens; and they not only render their writings immortal, but alſo make their very perſons known to poſterity. Thus, thoſe whoſe minds are acquainted with the pleaſantry of his writings, cannot avoid imagining in themſelves the figure of the poet Ennius, in the ſame manner as thoſe of the gods. And they who are delighted with the ſtudy of the poems of Accius, not only feel the energy of his words, but even his reſemblance ſeems to be preſent with them. Many alſo, born after our time, will diſpute with Lucretius, as if he were before their face, concerning the nature of things; with Cicero on the art of rhetoric; and confer with Varro, upon the Latin tongue. Nor will there be wanting many philoſophers, who will ſeem privately to deliberate and diſcourſe with the ſages of Greece. In fine, the ſentiments of excellent writers, although their bodies be abſent, exiſt in future ages; and in councils and debates have greater influence than thoſe of the perſons who may be preſent. Supported therefore, O Cæſar, by their authority, and following their opinions and precepts, I have written theſe books; the firſt ſeven, concerning building; the eighth, of water; and

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and the horizontal line *EF*, indefinitely; then take a rectangle *DAC*, move the angle *A* of it up the line *AB*, moving it from *B* upwards, and keeping one ſide *AD* cloſe to the point *D*, till the interſections of its two ſides *AD*, *AC*, with the lines *EF* and *BC*, make *BC* and *EF* equal; then *AB* and *BC* (=*EF*) will be the two mean proportionals required.

For want of a ſquare, it may be done with a common ruler, or ſtring, though with a little more difficulty, thus: Making the point *D* the axis, turn the ruler thereon, till the interſections *EF* and *GH* be equal, and *DH* equals *AB*. To help this latter operation, it will be uſeful to have a few perpendiculars drawn near about the place where *GH*, it is gueſſed, will happen. A demonſtration is ſcarcely neceſſary, as it will be evident on inſpection, that *DE*: *EF*:: *EF*=*CB*: *BA*, and :: *BA*: *BD*, they being all ſimilar ſides of ſimilar triangles, each having one ſide common.

The following method of finding two geometric mean proportionals ARITHMETICALLY, has alſo occurred to me. Multiply the ſquare of one of the given numbers by the other given number, and the cube root of that product will be one of the mean proportionals ſought. If the greater of the given numbers be that which is ſquared, the greater mean proportional will be the reſult; and the contrary if the leſſer given number be ſquared.

in this I ſhall explain the principles of dials; how they are to be contrived by means of the ſhadows of gnomons cauſed by the rays of the ſun, and on what principles they are enlarged or contracted.

CHAPTER IV.

Of the Conſtellations and Planets, relative to the Principles of Dialling.

THESE things are eſtabliſhed by the divine Mind, and excite great admiration when contemplated. The equinoctial ſhadow of gnomons is of a different magnitude at Athens, at Alexandria, at Rome, at Placentia, and at other parts of the earth, and therefore the forms of dials vary greatly in different places; for by the length of the equinoctial ſhadow are determined the forms of the analemmas[1*], by which, according to the difference of places, and ſhadows of the gnomons, the hour lines are deſcribed. The analemma is a figure contrived from the obſervation of the courſe of the ſun, and the increaſe of the ſhadow at the winter ſolſtice; and by means of which, with architectonic rules, and the uſe of inſtruments, the appearances in the ſyſtem are deſcribed. The world is the whole aſſemblage of all things in nature, and the heavens figured with the ſtars. Theſe revolve continually around the earth and ſea, upon the extremities of the cardinal (polar) axes; for in thoſe places the cardinal points are by the power of nature formed and ſituated as centers; one, from the earth and ſea, to the world's ſummit, beyond the northern ſtars themſelves; the other, on the contrary, under the earth, to the ſouthern regions; and there, around the cardinal orbicules, as around the centers in wheels, which the Greeks call *Poloi*, the heavens perpetually revolve. Thus the earth, with the ſea, is naturally placed in the middle; theſe are by nature ſo diſpoſed, that in the northern part, the center (the *pole*) is raiſed above the earth; while in the ſouthern part, being confined to the inferior regions, it is concealed by the earth[2*].

(1*) The analemma is deſcribed at the 8th chapter of this book.

(2*) Vitruvius here ſpeaks according to the Ptolemaic ſyſtem of the world, which was univerſally believed in his time; and according to the local ſituation of Italy, and the other parts of the earth then moſt known, which were wholly, or chiefly, in northern latitudes.

Through the middle, tranſverſely, and inclined to the ſouth, is formed the circular broad zone of the twelve ſigns[3*], whoſe repreſentations are delineated by nature in the diſpoſitions of their ſtars into twelve equal parts, which thus ſhining like the reſt of the ſtars, and revolving round the earth and ſea, deſcribe their courſe in the ſphere of the heavens: but all are viſible and inviſible at ſtated times; for when ſix ſigns are revolving in heaven above the earth, the others, paſſing under the earth, are obſcured by its ſhadow. Six of theſe, therefore, are always ſhining upon the earth; for as much of the ultimate ſign as by the force of the rotation deſcends and is hidden under the earth, ſo much of the oppoſite one is, by the revolving power, raiſed to view from the concealed and obſcured parts, as the ſame power actuates at once both the eaſtern and weſtern motions. Theſe ſigns are in number twelve, and each poſſeſſes a twelfth part of the heavens, turning continually from eaſt to weſt: and through theſe ſigns, but the contrary way, the Moon, Mercury, Venus, the Sun itſelf, as alſo Mars, Jupiter, and Saturn, as if aſcending on ſteps, run their courſe; traverſing the heavens, in orbits of different magnitudes, from the weſt to the eaſt. The Moon is twenty-eight days and about an hour more[4*] in paſſing the circuit of the heavens, from the ſign where it began its motion, to the ſame ſign returning; thus making a lunar month.

The ſun paſſes the ſpace of a ſign, which is the twelfth part of the heavens, in a month; thus pervading the twelve ſigns in twelve months; when, by returning to the ſame ſign from which it began its courſe, it meaſures the interval of a year. This circuit the Moon paſſes thirteen times in twelve months, while the Sun moves round it but once in the ſame time.

The planets Mercury and Venus, moving round the Sun itſelf as a center, ſeem ſometimes to be retrograde and to be retarded, as alſo, by the nature of their circuit, to be ſtationary and fixed in the place of the ſigns. This is chiefly obſerved in the planet Venus, which, when it follows the Sun, appears in the heavens after ſunſet, ſhining with great luſtre, and is called *Veſperugo*; at other times, preceding and riſing before the Sun, it is called *Lucifer*. Theſe are ſometimes delayed many days in one ſign: at other times they proceed ſwiftly in another ſign; but although they are not an equal number of days in each ſign, as much as they are delayed in a former, with ſo much the more celerity paſſing the following, they perform their courſe

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(3*) Called the zodiac.

(4*) This is not the time of its revolution according to the modern calculation; a periodical revolution of the Moon, which is the time of its paſſing from any one ſign till it returns to the ſame ſign again, being now found to be 27 days, 7 hours and 43 minutes; and a ſynodical revolution, which is the time between its conjunctions with the Sun, 29 days, 12 hours and 44 minutes. Pliny, l. 2. c. 9. ſays the time of the Moon's revolution is 27 days and about the third of a day, nearly agreeing with the modern computation.

exactly; for it ſo happens, that although they are retarded in ſome of the ſigns, yet when they free themſelves from the neceſſary delay, they paſs more quickly through the enſuing part of their orbits.

The planet Mercury ſo revolves in the heavens, that in 360 days, paſſing the circuit of the ſigns, it arrives at that ſign from whence it began its courſe; and its path is ſo equally divided, that it remains about 30 days in each ſign.

Venus, when it is freed from the obſtructions of the Sun's rays, moves the ſpace of a ſign in 40* days; and although it remains leſs than 40 days in ſeveral ſigns, yet when it is ſtationary, by being detained in one ſign, it regains the whole of its number. Therefore paſſing round the whole circuit of the heavens in 485 days, it returns again to that ſign from which it firſt began to move.

Mars, in about 683 days traverſing the ſpace of the ſtars, arrives again at the beginning of its courſe; and though it moves too quick in ſome ſigns, yet by being ſtationary in others, it revolves the juſt number of days.

Jupiter, with gentler motion aſcending the degrees, contrary to the rotation of the heavens, paſſes through each ſign in about 360* days, and is 11 years and 323 days in returning to the ſign, in which it was twelve years before.

(5*) This number is written 30 in all the editions; yet the tenor of the whole paſſage proves it is a miſtake, and that it ſhould be 40; for the very next ſentence, "Although the planet ſtays leſs than 40 days in ſeveral "ſigns, yet that deficiency is ſupplied by its ſtaying longer "in another ſign," clearly implies that Vitruvius meant it to be 40 days, which was about the number he ſuppoſed the planet ſtayed in each of the twelve ſigns: and alſo, that number multiplied by 12, equals the number of days he allows to the whole revolution, wanting 5, which may be ſuppoſed to be gained by its longer ſtay or retrogradation in ſome ſign.

(6*) This number 360, and the number 323 following, are in all the printed editions, except Galiani's, written 365, and 363; although, in all the manuſcripts I have examined, and in one at the Vatican library, they are as here written in the text. I have therefore, with Galiani, choſen thoſe numbers, as they agree more nearly with Ptolemy's calculation, as well as with the whole period of Jupiter's revolution, mentioned by Vitruvius.

But the times of the revolutions of the ſeveral planets, as here determined, by no means agree with the modern calculations, nor indeed with thoſe of other antient writers, particularly in the planets Mercury and Venus, which are different determined both by Ptolemy and Pliny. Ptolemy aſſigns 124 days to the revolution of the former, and 575 to the latter; and Pliny allows 339 to the former, and 575 to the latter: but theſe differences are doubtleſs owing to the falſe notion the antients had of the mundane ſyſtem.

The times of the periodical revolutions of the planets

Saturn is 31 months[7*] and a few days more in paſſing the ſpace of a ſign; and in 29 years and about 160 days, it returns to that in which it was thirty years before. This, as it is leſs diſtant from the extremity of heaven, is found to have a larger orbit, and to move ſlower.

Thoſe which make their circuit beyond the path of the Sun, when they are in trine[8*] chiefly, do not proceed, but being retrograde, are delayed till the Sun paſſes from the trinal ſign to another. Some aſſert this to be owing to their being then far diſtant from the Sun, where their paths not being enough enlightened, they are impeded by the ob frity: but it ſeems not ſo to us, for the brightneſs of the Sun is, without any obſcurity, perceptible and evident throughout the whole world, as appears to us even at the time theſe planets are retrograde and ſtationary. If then it is obſervable at ſuch a diſtance to our view, how can we ſuppoſe that it is obſcure to the divinity and ſplendour of the planets? We therefore rather maintain this principle, that as heat attracts and draws all things to itſelf; for we ſee fruits riſe out of the earth by the means of heat; as alſo by the rainbows, vapours from the ſprings of water riſing to the clouds: ſo for the ſame reaſon, the violent heat of the Sun's rays, extended in a triangular form, attracts the ſucceeding planets, and in the ſame manner ſtopping and retaining thoſe preceding, ſuffers them not to advance, but forces them to return, and remain in the other trinal ſign. It may perhaps be demanded, why the Sun, by its heat, cauſes this detention in the fifth[9*] ſign from itſelf, rather than in the ſecond or third, which are nearer. I ſhall explain this, as it appears to me. Its rays being extended in the heavens ſo as to form

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round the ſun, according to modern calculations, are as follow:

	Days.	Hours.	Min.
Mercury - - -	87	23	
Venus - - - -	224	17	
The Earth - - -	365	5	49
Mars - - - -	686	23	
Jupiter - - - -	4232	12	
Saturn - - - -	10759	8	

(7*) Perrault has obſerved, that if Saturn be 29 years and 160 days in paſſing its revolution, then it can be but 29 months and ſome days in each ſign, allowing 30 days to a month. But to this it may be anſwered, that Vitruvius may poſſibly mean lunar months, at the length he has juſt mentioned, viz. 28 days and about an hour; and in that caſe the words of the text will agree with the truth: for the planet will be 31 of thoſe months, 26 days and an half in each ſign, reckoning the year at 365 days, 5 hours, 49 minutes.

(8*) One of the aſpects of the planets. For the ſake of the following note it may be uſeful to recollect the ſeveral aſpects, conjunction, ſextile, quadrate, trine, and oppoſition: the firſt is when two planets are in the ſame ſign, or place, of the circle of the heavens; the ſecond, when they are 60 degrees, or a ſixth part of the circle diſtant; the third, when they are 90 degrees, or a fourth part of the circle diſtant; the fourth, when they are 120 degrees, or a third part of the circle diſtant; and the fifth, when they are 180 degrees, or half the circle diſtant.

(9*) Perrault has here differed from the text, and written the *fourth* inſtead of the *fifth*, as believing it to be a miſtake, cauſed by the copyiſts omitting the figure I before the figure V, and thus writing V inſtead of IV. Vitruvius undoubtedly means that ſign which is 120 degrees diſtant from the Sun: now as a planet, when it is 120 degrees diſtant from another, or in a trine aſpect, is then in the fifth ſign from it, if the two extreme ſigns be included, it may well be ſuppoſed that Vitruvius meant

a triangle of equal ſides, this will interſect neither further nor nearer than the fifth ſign; for if the rays were diſperſed through the whole world circularly, and not extended in the form of a triangle, the nearer bodies would then be more heated. This Euripides the Greek poet has alſo obſerved; for he ſays that which is further from the Sun has a more intenſe, and that which is nearer, a more moderate, heat: for in the dramatic fable of Phaeton, he writes thus: Καίει τὰ πόῤῥω, τὰ δ' ἐγγὺς εὐκρατ' ἔχει. *The diſtant burns, but gently warms the near.* If then the fact, reaſon, and the teſtimony of an ancient poet ſhew it to be thus, I think it ought not to be ſuppoſed otherwiſe, than as we have before written.

Jupiter performing his circuit between Mars and Saturn, revolves in an orbit greater than that of Mars, and leſs than that of Saturn: and the reſt of the planets, in proportion as they are further from the extremity of heaven, and have their orbits nearer to the earth, are found to move ſwifter: for thoſe which make a leſſer circuit will often paſs thoſe that are above them.

Thus if on a wheel, ſuch as the potters uſe, ſeven ants were put in as many grooves made in the wheel around the center, increaſing from thence to the extremity in which they were obliged to walk round, and the wheel was turned the other way, they would nevertheleſs make their circuit contrary to the rotation of the wheel; and thoſe which were nearer to the center would paſs round ſooner than thoſe at the extremity of the wheel, ſuppoſing they walked with equal celerity; for, on account of the magnitude of the circuit, they muſt be longer in paſſing their courſe. In the ſame manner the planets revolve in their orbits contrary to the courſe of the heavens, although they are carried backward by the prevailing rotation of the heavens in their diurnal motion.

But the reaſon that ſome of the planets are temperate, ſome hot, and ſome cold, is found to be this: that as all fire has a flame aſcending upward, ſo the Sun, by its rays, heating the

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that manner of reckoning, and therefore Perrault ſhould not have ſo haſtily altered the text. But Perrault urges, "that as the text oppoſes the fifth ſign to the ſecond, or "third, by which are meant the two aſpects, ſextile and "quadrate, they would, if that way of reckoning had "been uſed, have been called the third and fourth ſigns."

But this is taking it for certain that Vitruvius meant thoſe two aſpects by thoſe words; whereas it may as well be ſuppoſed that he meant, by the words ſecond and third, the ſigns that were next and next but one to the Sun; and this ſuppoſition will agree more nearly with the chief end and intention of his argument; which is to ſhew why the Sun affects thoſe planets which are farther from it, more than thoſe which are nearer. So in the ſcale of muſic, the note which is the fourth from the fundamental note, is called the fifth, becauſe the two extremes are comprehended, the fundamental note being reckoned the firſt; in the ſame manner Vitruvius may have here reckoned the ſigns.

æther above it, in the place where Mars has its courſe, that planet is rendered fervent by the heat of the Sun. Saturn, which is near the extremities of the world, and in contact with the frozen regions of heaven, is intenſely cold. But Jupiter, whoſe path is between the orbits of both, being qualified by their cold and heat, is found to have a moderate and temperate effect. Thus of the zone of the twelve ſigns, and of the ſeven planets, with their contrary action and courſe, by what laws, and at what times they paſs from ſign to ſign, and perform their circuit, I have diſcourſed according as I have learned from authors. I ſhall now ſpeak of the increaſe and diminution of the light of the Moon, as delivered to us by the antients.

Beroſus, who, from the city or nation of the Chaldeans, travelled in Aſia, and taught the ſciences, maintained the Moon to be a ball, half of which was luminous, and the other part of a blue colour: and that when, in the courſe of its circuit, it paſſes under the orb of the Sun, the rays and violent heat thereof attract and turn the bright ſide by the ſympathy of light to light: ſo that when the globe of the Sun is above it, then the lower part, which is not luminous, is, on account of its ſimilitude (in colour) to the air, inviſible. When it is thus perpendicular to the Sun's rays, the whole light is confined to the upper face, and it is then called the firſt day. When it paſſes the eaſtern part of the heavens, the attraction of the Sun being abated, the extremity of the bright ſide, in a thin line, emits its luſtre to the earth, and it is then called the ſecond day. Thus, by the daily remiſſion of the reverſement, the third and fourth days are numbered. On the ſeventh day, the Sun being in the weſt, the Moon will be between the eaſt and the weſt, in the middle part of the heavens; being then the half of the heavens diſtant from the Sun, the half of the luminous ſide will be turned to the Earth: but when the whole ſpace of heaven is between the Sun and Moon, and the Sun, paſſing the weſt, views the orb of the Moon behind it in the eaſt, being then at the greateſt diſtance from its rays, it is the fourteenth day, and the full circle of the whole diſc emits its light. The remaining days it decreaſes daily, till the completion of the lunar month, and its return to paſs again under the Sun, determining by its monthly rays the number of days. But as Ariſtarchus, the Samian mathematician, has with great judgment taught a different doctrine of the ſame, I ſhall here explain it.

He maintains that the Moon has no light of its own, but is as a ſpeculum (reflector), and receives its light from the Sun: of all the ſeven planets, the Moon revolves in the ſmalleſt orbit, and neareſt to the Earth; therefore the firſt day of every month paſſing under the Sun, it is inviſible; and, becauſe it is with the Sun, it is ſaid to be new. The next day, which is called the ſecond, having paſſed by the Sun, it has a thin illumination on the edge of the circle: the third day of its departure from the Sun, it becomes more illuminated: retiring every day more, at the ſeventh day, being about half the extent of the heavens diſtant from

the weſtern Sun, half of it ſhines; the part that is toward the Sun being illuminated.[10*] On the fourteenth day, when it is the ſpace of the whole heavens diſtant from the Sun, it appears full, and riſes when the Sun ſets: for, being the whole ſpace of the heavens diſtant, it ſtands diametrically oppoſite, and the whole orb receives the light of the Sun. On the ſeventeenth day, when the Sun riſes, it tends toward the weſt: the twenty-firſt day, when the Sun riſes, the Moon is about the middle of the heavens, and that ſide which is next to the Sun is enlightened; the other ſide being in ſhadow. So daily performing its courſe, about the twenty-eighth day,[11*] it again paſſes under the rays of the Sun, and thus completes its monthly rotation. I ſhall now deſcribe how the Sun, paſſing through a ſign every month, lengthens and ſhortens the days and hours.

(10*) "Et ejus quæ ad Solem pars ſpectat ea eſt illumi-" nata"—" The part that is toward the Sun being illu-" minated." Perrault finds no ſenſe in this paſſage, as here ſituated; he has therefore judged it ſhould be placed a few lines before; i. e. ſo as to follow the word *obſcuratur*, and has rendered his tranſlation accordingly: but theſe words are as applicable, and may be as juſtly ſaid, when the Moon is a quarter of its revolution diſtant from the Sun, as when it is in conjunction; and it is extraordinary that Perrault ſhould think otherwiſe. If the words be equally juſt in both caſes, it is no fault in Vitruvius that they are not placed where Perrault would have them: indeed Perrault ſeems to have haſtily written his ideas, without conſideration, or the uſe of his judgment, in this, as well as in many other alterations that he has made.

(11*) Vitruvius has before in this chapter mentioned 28 days as the time of the *periodical* revolution of the Moon, and here it is applied to its *ſynodical* revolution; with neither of which it exactly agrees. See note 4 foregoing.

CHAPTER V.

Of the Courſe of the Sun through the Twelve Signs of the Zodiac.

WHEN the Sun enters the ſign of Aries, and has proceeded an eighth part therein, it cauſes the vernal equinox[1*]; when it has advanced to the tail[2*] of Taurus, and to the ſtars of Vergiliæ, which are conſpicuous in the prior half of Taurus, it has paſſed in the heavens more than half of its courſe to the north. From Taurus, entering Gemini at the riſing of the Vergiliæ, it advances more upon the earth, and increaſes the length of the days; then from Gemini entering Cancer, which occupies the leaſt part of the heavens, when it arrives at the eighth part thereof, it determines the ſummer ſolſtice, and moves on to the head and breaſt of Leo; for thoſe parts are aſſigned to Cancer. From the breaſt of Leo, and end of Cancer, the Sun, paſſing through the remaining part of Leo, diminiſhes the length of the days, and its circuit; making the ſame courſe as when in Gemini. Paſſing from Leo to Virgo, and proceeding to the ſinus of her veſt, it leſſens its circuit, and makes a courſe equal to that which it made when in Taurus. Proceeding from the ſinus of Virgo, which ſinus includes the firſt part of Libra, it produces the autumnal equinox; the circuit being then equal to that it made when in the ſign Aries. When the Sun enters Scorpio, at the ſetting of the Vergiliæ, it diminiſhes the length of the days, proceeding to the ſouthern parts. From Scorpio, paſſing to the thigh of Sagittarius, it cauſes the days to be yet ſhorter. From the thighs of Sagittarius, part of which is attributed to Capricornus, entering on eight parts of the latter, it then makes the ſhorteſt tract in the heavens; which time is, from the ſhortneſs of the days, called *Bruma*, and the days *Brumales*. From Capricornus, paſſing to Aquarius, it increaſes and makes the days equal in length to thoſe of Sagittarius: from Aquarius, entering Piſces, at which time the wind Favonius

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(1*) This is not the caſe at preſent; for by a motion that alters the place of the equinoxes about 50 ſeconds of a degree every year, called the preceſſion of the equinoxes, the vernal equinox is moved almoſt 30 degrees from the place aſſigned by the antient aſtronomers.

(2*) The conſtellation Taurus is repreſented without a tail and hinder parts, on the modern ſpheres; whether therefore it was by the antients differently repreſented, or that we are to underſtand by this expreſſion the extremity of the ſign, is uncertain. Pliny, b. 2. ch. 41. mentions the ſeven ſtars called Vergiliæ being in the tail of Taurus.

blows, its courſe is equal to that when in Scorpio: thus the Sun pervading the ſigns at ſtated times, increaſes and diminiſhes the length of the days and hours.[3*]

I ſhall now ſpeak of the other conſtellations that are on the right and left of the Zodiac; and of the ſtars diſpoſed on the northern and ſouthern part of the heavens.

CHAPTER VI.

Of the Conſtellations that are on the North of the Zodiac.

SEPTENTRIO,[1*] which the Greeks name *Arcton*, or *Helicen*, has behind him his Keeper,[2*] who is not far from Virgo; over whoſe right ſhoulder is a moſt brilliant ſtar, called by us *Provindemia Major*, and by the Greeks *Protrygeton*, which ſhines with an extraordinary luſtrous colour; oppoſite to it is another ſtar, between the knees of the Keeper of Arctus, who is called Arcturus. From the head of Septentrio, toward the feet of Gemini, is the part aſſigned to Auriga, who ſtands at the point of the horn of Taurus; alſo at the point of the left horn, by the feet of Auriga, is a ſtar called the Hand of Auriga, by whoſe left ſhoulder are the Goats' Kids. Above Taurus and Aries, is Perſeus, paſſing under, on the right, the baſe of the Vergiliæ, and on the left, the head of Aries; with the right hand reſting upon the figure of Caſſiopeia, the left holding over Auriga[3*] the Gorgon's head, by the top, and laying it under the feet of Andromeda. The Fiſhes alſo, above Andromeda, and by the belly of

(3*) The Romans divided the day, whether long or ſhort, into twelve hours, as Vitruvius obſerves at the 8th chapter following; beginning at ſun-riſe, and ending at ſun-ſet: therefore, in all their dials and contrivances to meaſure time, the hours were lengthened and ſhortened with their days.

(1*) Called alſo *Urſa Major*, the Great Bear.

(2*) Boötes, or Arcturus, according to Vitruvius.

(3*) Galiani has changed *Aurigam*, in the text, to Taurum, becauſe he ſays "Perſeus holds the Gorgon's "head over Taurus, not over Auriga." This is true, if we conſider the north pole as the upper part, as Galiani ſeems to have done; but as Perſeus is diſpoſed with his feet upon Auriga, and his head weſtward, the weſt, with reſpect to him, may be conſidered as the upper part, and Auriga may be ſaid to be below him; conſequently Perſeus, in that view, holds the Gorgon's head over Auriga. This may be the view in which Vitruvius has conceived it, and in this view the text is juſt, and the alteration of Galiani erroneous.

her and of the Horſe, are over the back of the Horſe; and a glittering ſtar limits the belly of the Horſe and the head of Andromeda.

The right hand of Andromeda is placed upon the image of Caſſiopeia, the left over the north-eaſtern Fiſh. Aquarius is over the head of the Horſe, the hoofs[4*] of the Horſe touching the knees of Aquarius: the middle of Caſſiopeia is dedicated to Capricornus.[5*] High above are Aquila and Delphinus; near them is Sagitta; and by him the Swan, of which the right wing touches the hand of Cepheus, whoſe ſceptre, in his left hand, reſts upon Caſſiopeia. The feet of the Horſe are concealed under the tail of the Bird.[6*]

Over Sagittarius, Scorpio and Libra, is the Serpent, the point of whoſe beak touches the crown. At the middle of the ſame place is Ophiuchus,[7*] holding the Serpent in his hand, his

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(4*) Here muſt be ſome error in the text, which runs thus: "Item Aquarii ſupra Equi capitis, Equi ungulæ "attingunt Aquarii genua: Caſſiope media eſt dedicata "Capricorno:" for Vitruvius has ſaid that the Fiſhes are at the back of the Horſe. Aquarius is next to them in the line of the Zodiac, and (as Vitruvius ſays) at the head of the Horſe: alſo the feet of the Horſe are hereafter deſcribed to be under the Swan's tail. It is therefore not poſſible, in this ſituation of things, that the hoofs of the Horſe can touch the knees of Aquarius. Wherefore Philander and Perrault judge that, inſtead of *Aquarii genua*, Aquarius's knees, *Avis pennæ*, the Bird's wings, ſhould be read; and Galiani has changed *ungulæ*, hoofs, to *auriculæ*, ears, which is the more probable correction: although this will not agree with the delineation on the globes. If we might read *gula*, throat, inſtead of *genua*, knees (and it is not very improbable that the word may have been ſo changed by the copyiſt), the reading would then, if joined with Galiani's correction, agree with the uſual appearance on the globes. See the following note.

(5*) "Caſſiope media eſt dedicata Capricorno." Caſſiopeia is at ſo great a diſtance from Capricorn, that it is not likely Caſſiopeia was here meant by the author: Galiani has therefore changed *Caſſiopeiæ* to *Aquarii*: and Perrault has altered the ſenſe of the paſſage by altering the punctuation.

Caſſiope is written in all the manuſcripts I have examined, except one, wherein all the words between *Aquarii* and *Media*, quoted in the preceding note, are omitted, and where conſequently the ſenſe is, that the middle of Aquarius is dedicated to Capricorn, agreeing with the alteration of Galiani.

(6*) "Abea antem volucris cujus penna dextra Cephei "manum attingit, & ſceptrum læva ſupra Caſſiopeia in-"nititur."

Perrault and Galiani tranſlate this paſſage thus: "the "right wing touches the hand and ſceptre of Cepheus, "and the left wing extends to Caſſiopeia." But this cannot be juſt; becauſe Cepheus does not hold the ſceptre in the hand that touches the right wing of the Swan, but in his left hand, which is near Caſſiopeia; nor does the left wing of the Swan extend toward Caſſiopeia, either in the modern globes, or in the antique ſphere preſerved in the Farneſe palace at Rome. The text will very well bear the conſtruction that I, following Barbaro, have given it, which exactly conforms to the repreſentation on the globes. The words "læva ſupra Caſſiopeia innititur" more probably relate to the left hand of Cepheus, than to the left wing of the Swan (although it may be inaccurately expreſſed), becauſe the poſition of Cepheus is not otherwiſe fully deſcribed; and the left wing of the Swan in no globe extends to Caſſiopeia, but to the Horſe's feet: for this reaſon alſo, I believe the words "ſub Avis cauda"—"under the tail of the Bird," following the above quotation, ſhould have been written "ſub Avis penna"—"under "the wing of the Bird;" for the feet of the Horſe are under the left wing of the Swan, not under its tail, in the antient as well as in the modern globes.

(7*) The Serpent-holder, called Serpentarius.

left foot treading on the middle of Scorpio. Not far from the head of Ophiuchus is the head of him who is called the Kneeler[8*]; the tops of their heads are eaſily diſtinguiſhed, being marked by bright ſtars. The foot of the Kneeler is ſupported by the head of the Serpent[9*], that is entwined between him and Arctus, otherwiſe called Septentrio[10*]. At a little diſtance from them is Delphinus[11*]. Lyra is placed oppoſite to the bill of the Swan. The Crown is between the ſhoulder of the Keeper and the Kneeler.

In the northern circle are two Bears, diſpoſed with the back of their ſhoulders to each other, and their breaſts the contrary way; the leſſer is by the Greeks called *Cynoſoura*, and the greater *Helicen:* they are repreſented with their heads looking down from each other, and their tails turned toward the other's head; for of both it may be ſaid, that they are exceedingly conſpicuous by their tails: the Serpent (*Draco*) is extended from that ſtar which is called Polus, and ſhines moſt about the head of the Greater Bear[12*]; for Draco involving the head of that to which it is neareſt, folding once near the head of Cynoſura, and then extending to its feet, bends itſelf, and returns from the head of the Leſſer (Bear) with its beak oppoſed to the Greater (Bear), and ſhewing the right ſide of its head. Upon the tail of the Leſſer (Bear) are the feet of Cepheus; and at the part of the Zenith which is over the head of

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(8*) Hercules.

(9*) Draco.

(10*) Urſa Minor, or the Little Bear.

(11*) Philander and Perrault would here alter the text, and inſtead of "parve per eos flectitur Delphinus," read "parvi Equi os flectitur Delphinus:" becauſe Delphinus is at a conſiderable diſtance from the conſtellations here ſpoken of, and is near the little Horſe called Equiniculus.

It appears to me that the correction ſhould be made by reading *Antinous* inſtead of *Delphinus*, ſuppoſing the latter to have been written by miſtake inſtead of the former; for the former well correſponds with the deſcription, being but at a little diſtance from Ophiuchus (of which Vitruvius was ſpeaking), and has not before been mentioned; nor is it at all mentioned by Vitruvius among the conſtellations, unleſs we ſuppoſe it to be here meant; whereas the latter, i. e. Delphinus, he has deſcribed before.

(12*) This is an exceeding intricate and confuſed paſſage, and if the deſcription is not erroneous, it is however very different from that which the modern diſpoſal of the conſtellations will authorize; inſomuch that Galiani has thought proper to reject the common reading, tranſpoſe and change the words, and indeed make a new text of his own. The text, as I find it in the common editions, and in ſeveral manuſcripts, is, "Utrorumque "enim ſuperando eminent in ſummo per caudas eorum "eſſe dicitur; item Serpens eſt porrecta equa ſtella quæ "dicitur Polus, plus elucet circum caput majoris Septen-"trio, namque," &c.

Galiani has altered it to "figurantur utrorumque enim "ſuperando eminent in ſummo equa ſtella quæ dicitur "Polus, plus elucet circum caudam minoris Septentrionis, "per caudas eorum eſſe dicitur item Serpens eſt porrecta, "namque," &c.

As no part of the current text, one word excepted, contradicts the uſual repreſentation of the conſtellations on the globes, I have adhered to it in the tranſlation. I would change only *majoris* for *minoris*; becauſe the ſtars in Draco environ the head of the Leſſer Bear rather than that of the Greater, and the copyiſts may eaſily have miſtaken one of thoſe words for the other. The ſenſe then of the paſſage may be this: "for both are exceedingly "conſpicuous above by their tails; alſo the Serpent is "extended from that ſtar that is called Polus, and ſhines "more about the head of the Leſſer Bear."

Aries, are the ſtars forming a triangle of equal ſides. In Septentrio Minor and Caſſiopeia there are alſo many ſcattered ſtars.[13*]

Having ſpoken of thoſe conſtellations that are diſpoſed in the heavens to the right of th eaſt, between the Zodiac and the north, I ſhall now deſcribe thoſe that are ſituated by nature in the ſouthern parts, to the left of the eaſt.

CHAPTER VII.

Of the Conſtellations on the South of the Zodiac.

FIRST, under Capricornus is the ſouthern Fiſh, looking toward the tail of the Whale:[1*] from thence to Sagittarius the place is void. The Altar is under the ſting of Scorpio. Toward Libra and Scorpio are the fore parts of the Centaur, holding in his hands that which aſtronomers call the Beaſt. Near Virgo, Leo, and Cancer, the Hydra winding through a range of ſtars, begirts the place of Cancer, erecting his beak to the Lion; and in the middle of his body ſupporting the Cup: under the hand of Virgo lies its tail, on which is the Crow. Thoſe (ſtars) that are on its ſhoulders are equally bright: under the belly of the Hydra,[2*] at its tail, is the Centaur.

(13*) Galiani has here again altered the text, changing *Caſſiopeia* to *Cephei:* for he having tranſlated *confuſæ* by *communes*, making the text ſay "there are many ſtars com-"mon both to Septentrio Minor and Cepheus," he was obliged to change the name of the conſtellation to make the text agree with his idea.

But as the word *confuſæ* may bear the meaning I have given it, the text may, without any imputation of error, remain unaltered.

(1*) *Cauda proſpiciens Cephea* are the words in the printed editions; but it is univerſally agreed that they are erroneous. Philander, who is followed in this by many others, is of opinion, that the original words were *caudam proſpiciens Ceti*, ſignifying that the fiſh *is looking toward the tail of the Whale:* as is the fact, according to the modern globes; for Cepheus is at ſo great a diſtance among the northern conſtellations, that it is not probable Vitruvius ſhould allude to him in this place, where he is treating of the ſouthern conſtellations. In ſeveral manuſcripts I find the words are *caudam proſpiciens Cephei*; ſo that very likely the error may be in the laſt word only, which may have been written inſtead of Ceti.

Perrault tranſlates it thus—*and its tail is turned toward Sagittarius*; accepting the word to be Centaurum, inſtead of Cephea, and then underſtanding Sagittarius to be thereby ſignified.

(2*) Perrault ſays it is not eaſy to gueſs whoſe ſhoulders Vitruvius here ſpeaks of; for there are no bright ſtars on the ſhoulders of Virgo, which nevertheleſs ſeem to be thoſe that are deſcribed in the text.

Near the Cup and Leo is the ſhip called Argo, whoſe prow is inviſible; but the maſt, and thoſe parts that are next the ſteerage, are plainly ſeen. The poop of the ſame ſhip joins the point of the Dog's tail. The leſſer Dog, under Gemini, goes before the head of the Hydra; the greater alſo follows the leſſer. Orion is depreſſed tranſverſely under the hoof of Centaurus,[3*] holding it with his left hand, and raiſing the club in his other hand to Gemini.[4*] The head of the Hare, which is at a little diſtance from the Dog, is his footſtool. Under Aries and Piſces lies the Whale, from whoſe creſt narrow ſtreams of ſtars, which the Greeks call *Hermedone*, extend to both the Fiſhes; and from that great diſtance the ligature of the Fiſhes[5*] reaches to the top of the Whale's creſt. Eridanus[6*] flows in the form of a river of ſtars, taking its beginning from the left foot of Orion. The water that is poured from Aquarius runs between the head of the ſouthern Fiſh and the tail of the Whale.

The appearances of the ſtars, figured and formed in the heavens by nature and the Divine Mind, as the philoſopher Democritus believes, I have now explained. But we can only obſerve and diſcover ſuch of them as riſe and ſet; for as Septentrio turns around the cardinal axis (the north pole), without ſetting or paſſing under the earth, ſo around the ſouthern car-

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Galiani reproves Perrault for this idea, and obſerves that Vitruvius is here ſpeaking of the Serpent, i. e. Hydra, not of Virgo; intimating that it is the ſhoulders of the Serpent that Vitruvius means, and to which we muſt look for the *ſtars equally bright* that he mentions. We ſeem deſtined to differ from each other; and in this I muſt differ from both Galiani and Perrault, believing that the ſhoulders of the Crow are here meant: for Vitruvius is ſpeaking of the Crow, which he has juſt before named; and on whoſe ſhoulders there are, in fact, two large ſtars of equal luſtre; whereas there are no ſuch ſtars on the Serpent, or Hydra; nor can the term ſhoulders be properly applied to ſerpents, whoſe bodies are not formed with any part like a ſhoulder. Galiani ſeems to have been aware of this, and has tranſlated *ſcapulas, the back*, not *the ſhoulders*, which it properly ſignifies.

(3*) This ſhould undoubtedly be *Taurus*, not *Centaurus*: the ſituation of the two conſtellations plainly prove it to be an error, as is obſerved by all the commentators; for Vitruvius has before mentioned Centaurus to be near Libra and Scorpio; and here he ſays, Orion extends one hand to Gemini; he cannot therefore be near Centaurus.

(4*) "Orion vero tranſverſus eſt ſubjectus preſſus ungula Centauri (Tauri), manu læva tenens clavam alteram "ad Geminos tollens." Theſe words have been generally underſtood to ſignify that Orion is ſituated under the hoofs of the Bull, holding in his left hand a club, and extending the other to Gemini; directly contrary to the uſual repreſentation, in which Orion holds the club in his right hand, extending the ſame to Gemini.

Galiani has therefore inſerted the word *clypeum* between *tenens* and *clavam*, and changed *alteram* to *altera*, thus making the text ſay that Orion holds a ſhield in his left hand. But without altering the text, by making the ſtop after *tenens*, it will agree with the repreſentation on the ancient globe, in which Orion is repreſented holding a mantle in his left hand, cloſe to the hoof of Taurus, and raiſing the club in his other hand to Gemini. Galiani's alteration of the text is therefore unneceſſary. Perrault alſo in his notes has miſtakingly ſaid that Orion holds the club in his left hand, raiſed toward Gemini; whereas he holds the club in his right hand.

(5*) The text has here *ſerpentium*, by which is ſuppoſed to be ſignified the *fiſhes* of which Vitruvius is now ſpeaking.

(6*) So named from the river now called *Po*.

dinal point, which by the inclination of the heavens is ſituated under the Earth, there are other conſtellations revolving that are unſeen, never riſing above the Earth; therefore their appearances, on account of the intervention of the Earth, are unknown. Of this the ſtar Canopus[7*] is a proof, which is not known in theſe countries, otherwiſe than by the reports of the merchants who travel to the extreme parts of Egypt, and near to the utmoſt limits of the Earth.

I have thus treated of the revolutions of the heavens around the Earth, of the twelve ſigns, and the diſpoſition of the northern and ſouthern conſtellations, as they are ſeen; becauſe, by the rotation of the heavens, the contrary courſe of the Sun through the ſigns, and the equinoctial ſhadows of gnomons, the conſtruction of the anallemnas is to be found. As for the other part of aſtrology, concerning the influence of the twelve ſigns, the five planets, and the Sun and Moon, upon human life, it is to be left to the Chaldeans, to whom belongs the ſcience of *genethliologia*,[8*] ſo that they can diſcover, by the aſpects of the ſtars, both the paſt and the future. The accounts of their diſcoveries, which they have left in writing, prove their judgment and ingenuity, and what great men the nation of the Chaldeans has produced. Firſtly Beroſus, who ſettled in the iſland and city of Coos,[9*] and there eſtabliſhed a ſchool. Afterward came Antipater and Achinapolus, who left a treatiſe on the art of Genethliologia, not from the birth, but from the conception. Of natural things, Thales the Mileſian, Anaxagoras the Clazomenian, Pythagoras the Samian, Zenophantes the Colophonian, and Democritus the Abderite, have written; and have left their doctrines concerning the cauſes by which things are governed, and how they produce their effects.

The diſcoveries of theſe men were proſecuted by Eudoxus, Eudæmon, Calliſtus, Melo,[10*] Phillippus, Hipparchus, Aratus, and others, who by aſtrology, and the uſe of the parapegmatum,[11*] diſcovered the riſing and ſetting of the ſtars, and the indications of the weather; and have left them explained to poſterity. The knowledge of ſuch men is revered by mankind; for ſo great is their judgment, that even, like divinities, they pronounce beforehand the weather that ſhall afterward happen; wherefore theſe things ought to be committed to their care and application.

(7*) A large ſtar in the conſtellation of the Ship. Pliny, b. 2. ch. 70, obſerves, that it is not ſeen in Italy, but is juſt ſeen at Rhodes.

(8*) The ſcience of foretelling future events in the lives of mankind, and the ſtate of the weather.

(9*) An iſland in the Archipelago, near Rhodes.

(10*) Perrault writes Euchæmon, Calippus, Meto, which are the names of aſtronomers mentioned by Ptolemy.

(11*) An aſtronomical inſtrument, according to the opinion of ſome; according to others, a braſs table containing aſtronomical repreſentations.

CHAPTER VIII.

Of Sun-dials, and of the Equinoctial Shadow of Gnomons at Rome and ſome other Places, with a Deſcription of the Anallemna.

FROM theſe men we derive the principles of dialling, and are enabled to explain the cauſes of the decreaſe of the days in each month, as alſo the depalations[1*]; for at the time of the equinoxes, when the Sun is paſſing Aries and Libra, the gnomon having nine parts, its ſhadow will have eight in the latitude of Rome. At Athens, the gnomon having four parts, the ſhadow will have three. At Rhodes it is as five to ſeven.[2*] At Tarentum, as nine to eleven. At Alexandria, as three to five: and ſo in all other places, according to their ſituations, the equinoctial ſhadow of the gnomon is obſerved to be different. Wherever therefore ſun-dials are to be deſcribed, the equinoctial ſhadow, at that place, muſt be taken.

Fig. LXIX. If it ſhould be the ſame as at Rome, the ſhadow having eight of the nine parts of the gnomon, a line is deſcribed on a plane, and from the middle, *pros orthas*,[3*] is to be erected that which is called the gnomon; and from the line which is on the plane at the end of the gnomon, a ſpace equal to nine parts is to be meaſured thereon with the compaſſes; and in that place, where the mark of the nine parts happens, as at the letter *A*, a center is to be fixed. Then extending the compaſſes from this center to the line of the plane, where the letter *B* is, a circle is deſcribed, which is called the meridian; then of the nine parts which extend from the plane to the center (at the top) of the gnomon, eight are taken, and marked on the line that is in the plane, at letter *C*; this will be the equinoctial ſhadow of the gnomon: and from the mark at letter *C*, through the center *A*, a line is drawn, which will be the ray of the Sun at the equinoxes. Then from the center, opening the compaſſes to the line on the plane, ſet that meaſure from the plane on the circumferent line, on either

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(*1) This word is in ſome manuſcripts written *explanationes*. Some ſuppoſe it to ſignify the method of finding the increaſe and decreaſe of the ſhadow of the gnomon; coming from the word *palor*, to ſtraggle, or wander irregularly: or it may ſignify the unequal and various divergence of the hour lines.

(2*) Perrault tranſlates it as nine to ſeven—by miſtake, I ſuppoſe; for the words are *ad ſeptem Rhodo quinque*.

(3*) At right-angles, or perpendicularly.

ſide, where the letter *E* is on the left, and *I* on the right ſide; and from theſe points a line is drawn through the center that divides the two ſemicircles: this line is by the mathematicians called *horizon.*

Then taking the fifteenth part of the whole circumference, and placing the central foot of the compaſſes in the circumferent line, at that point in which it is interſected by the line of the equinoctial ray, where the letter *F* is, marks are made to the right and left, where the letters *G* and *H* are, through which, from the center, lines are drawn till they meet the line on the plane, at the letters *T* and *R*, which will repreſent the rays of the ſun, the one at winter, and the other at ſummer.[4*] Oppoſite to the letter *E*, where the circumference is interſected by the line drawn through the center, will be *I*; oppoſite *G* and *H* will be the letters *K* and *L*; oppoſite *C*, *F*, and *A*, will be the letter *N:* then diametral lines (chords) are drawn from *G* to *L*, and from *H* to *K*, the inferior of which will be the part of ſummer, the ſuperior that of winter.

Theſe chords are divided in the middle at the letters *M* and *O*, where centers are made, through which, from the center *A*, a line is drawn to the extreme circumferent line, where the letters *P* and *Q* are; this line will be at right angles to the equinoctial ray, and is called by the mathematicians *axon:* from theſe centers, extending the compaſſes to the extremity of the chords *LG* and *KH*, two ſemicircles are deſcribed, one of which will be for ſummer, and the other for winter. Then in the places where the parallel lines interſect the line which is called horizon, on the right ſide is the letter *S*, and on the left *V*, and from the extremity of the ſemicircle at *G* a line parallel to the axon is drawn to the left ſemicircle, where the letter *H* is, which parallel line is called *lacotomus*[5*]; then the central foot of the compaſſes being applied at that place, where it interſects the equinoctial ray, at the letter *X*, and the other foot extended to that point where the ſummer ray cuts the circumference at the letter *H*, at the center in the equinoctial, with the ſummer interval, the circle *HGC* of the months, which is called *manacus*[6*], is deſcribed: thus we ſhall have the figure of the analemna.

Fig. LXIX.

(4*) This ſuppoſes the inclination of the ecliptic, at the time of Vitruvius, to be 24 degrees, which is the fifteenth part of the whole circumference; that inclination is found to be at this time 23 degrees and $\frac{1}{2}$ nearly, or 23° 28′ $\frac{1}{2}$, which favours the opinion of a gradual diminution in the obliquity of the ecliptic.

(5*) Turnebus reads *leiotomus*, cutting the left; as this line cuts the left or ſummer ray, *AR.*

(6*) By dividing this circle of the months into twelve equal parts, for the ſituation of the Sun in the twelve months of the year, or ſigns of the zodiac, the noon ſhadow of each month may be found; for by marking on the line *HG* the direct diſtances 1. 2. 3. 4. of thoſe diviſions from the equinoctial ray, thoſe marks will re-

This being deſcribed and explained, either by the lines of the winter, or the ſummer, or the equinoctial, or even of the months, the projection of the hour lines may, from the analemna, be drawn; and many different kinds of dials may be contrived and deſcribed by the means of this device: for the effect of the deſcriptions and figures of all of them are the ſame; the equinoctial, as well as the winter and (ſummer) ſolſtitial days, being equally divided into twelve parts.[7*] Theſe figures are not omitted from negligence, but to avoid offending by too much writing. I ſhall relate, however, by whom the ſeveral kinds of dials were invented; for neither can I diſcover a new kind, nor will I publiſh thoſe of others for my own: I ſhall therefore mention thoſe that have come to our knowledge, and by whom they were invented.

CHAPTER IX.

Of the Conſtruction and Uſe of Dials, and of their Invention and Inventors.

THE ſemicircle excavated in a ſquare, undercut to the inclination of the climate, is ſaid to have been invented by Beroſus the Chaldean. The Scaphe, or Hemiſphere, by Ariſtarchus the Samian, as alſo the Diſcus on a plane. The Arachne by Eudoxus the aſtronomer, although ſome ſay by Apollonius. The Plinthium, or Lacunar, one of which is in the Circus Flaminius, by Scopas the Syracuſan. The *Pros ta hiſtoremena* by Parmenion. The *Pros pan clima* by Theodoſius and Andreas. The Pelecinon by Patrocles. The Cone by Dionyſiodorus. The Pharetra and other kinds by Apollonius. Many others alſo, as well as thoſe above mentioned, have been invented, as the Gonarch, the Engonatos, the Antiborœum; as likewiſe the pendent travelling kinds, of which many authors have written, and from whoſe

preſent the diſtance of the Sun from the equinoctial in each reſpective month. Wherefore drawing lines from the top *A* of the gnomon, through thoſe marks, to the plane *BT*, the length of the noon ſhadow in each month will be thereby determined.

(7*) This paſſage is a confirmation of the fact, that the antients divided the day, whether long or ſhort, into twelve hours, beginning at ſun-riſe, and ending at ſun-ſet, and their dials were formed on that principle. See the following chapter.

books whoſoever will may learn the conſtruction, provided they underſtand the analemma.[1*] There are alſo water dials, invented by the ſame authors: the firſt of this kind was by Cteſibius the Alexandrian; who alſo explained the nature of the air, and the art of Pneumatics. But it may be worthy of attention to know how theſe were diſcovered.

Cteſibius was born at Alexandria; his father was a barber. He being ingenious, and

(1*) The preciſe form and conſtruction of the dials here mentioned cannot now be, with any certainty, determined or explained. Some conjectures only concerning them may be made from their names. The Scaphe, from the general meaning of the term, we may conclude was a hemiſphere of the concave kind. The Diſcus, for the ſame reaſon, was probably a dial formed as a horizontal circular plane. The Arachne, like a ſpider's web. The *Plinthium* is in ſome manuſcripts written *Pantium*; and *Lacunar* Baldus would alter to *Laterem*, as more ſuitable in its meaning to *Plinthium*, expreſſing a cubical or ſolid body, which is ſuppoſed to be the form of the dial here mentioned; whereas the term *Lacunar* is expreſſive of a hollow, or excavation. The *Pros pan clima* is a dial ſo conſtructed as to ſuit all climates: but what ſort the *Pros ta hiſtorumena* ſignifies, is not agreed on; ſome ſuppoſe that the term expreſſes a kind of dial made for all parts of the earth that were known, or mentioned in hiſtorical or geographical deſcriptions. The Pelecinon, or Ax—and the Pharetra, or quiver, were probably dials of a form like thoſe inſtruments. The Gonarch and Engonatus, to gueſs from the meaning of the words, may have been of the angular kind. And the Antiboraum an antartic or ſouthern dial, or one diſpoſed to the ſouth.

In Poleni's *Exercitationes Vitruvianæ* is an attempt to diſcover the Hemicycle of Beroſus, by Jacob Ziegler; and in the Giornale de' Litterati, for the year 1746, is alſo a comment on an antient dial found at Fraſcati in Italy, by P. Boſcovick, who ſuppoſes it to be that called the Hemicycle of Beroſus. Mr. Stuart likewiſe found at Athens an antient ſun-dial that ſo well agrees with the ſhort deſcription Vitruvius gives of this Hemicycle, that it is not improbable it may be the ſame. It is repreſented at *Fig. LXX.* *ABCD* is the front elevation, *AMNE* the ſection through the middle, and *AOPB* the upper ſurface, or top. The dial ſtands on the ſouthern ſide of the rock of the Acropolis, and is a little disjointed from the baſe on which it was originally fixed.

Mr. Stuart has given an engraving of it in the Vignette of the fourth chapter of his ſecond volume of Athenian Antiquities, but without the figures. I have therefore inſerted it here with the figures, in order to preſerve this curious relick of antiquity.—The plane *ABCD* is ſuppoſed to be parallel to that of the equator; its inclination from the perpendicular is 36° 37′, by Mr. Stuart's meaſurement: although according to Vitruvius (who in the foregoing chapter ſays the equinoctial ſhadow at Athens is to the gnomon as 3 to 4) it ſhould be 36° 43′. This difference, Mr. Stuart ſuppoſed, might be owing to the upper ſurface of the dial being ſo much injured by the weather, as made it impoſſible to meaſure it accurately. The line *EF* inclines about 8° 45′ from the perpendicular. The hour lines are all equidiſtant. The line *GG* ſhews the winter ſolſtice, *HH* the equinoctial, and *AE* the ſummer ſolſtice. The gnomon, or ſtyle, was probably a horizontal bar, fixed on the top, and of ſuch a length that the end of its ſhadow reached to the line *AE* at the ſummer ſolſtice, and to the line *GG* at the winter ſolſtice. The meaſures are in Engliſh feet and inches, and all that were in Mr. Stuart's ſketch are here inſerted.—Another antient dial (No. 2, *Fig. LXX.*), formed on the ſame principle, but of a ſmaller ſize, is at the earl of Beſborough's at Roehampton, and is a very valuable piece of antiquity. The inclination of the plane *AB* (ſuppoſed to be that of the equator) is about 31 degrees from the perpendicular, which is the latitude of Alexandria in Egypt; wherefore it is probable this dial was made for that antient city. The centre *D*, from whence the hour lines iſſue, is a little above the preſent top of the ſtone; probably ſo much as was equal to the thickneſs of the gnomon, which, by the holes yet remaining, ſeems to have been there fixed. The intervals *e*, *f*, *g*, of the hour lines at either extremity, are leſs than thoſe in the middle at *i*: but this may be owing to the figure of the excavation not being truly ſemicircular; for, had it been ſo formed, I find by trial that the intervals would have been all equal. This however is not the caſe in the Athenian dial; for the intervals therein are all equal, although the curve of the excavation appears to be parabolic.

withal exceedingly induſtrious, was called "the delighter in works of art." Endeavouring to ſuſpend a ſpeculum in his father's ſhop, ſo that it ſhould be drawn up and down by a ſecret line and weight, he contrived it thus: He fixed a wooden channel under the beam, and placed there a pulley; through the channel he paſſed a cord to the angle (of the room), where he made tubes, down which he let a leaden ball with a ſtring. It happened that the weight deſcending into the narrow tubes, and compreſſing the incloſed air, violently forced it through the ſeveral apertures into the open air, and thereby produced diſtinct ſounds. When therefore Cteſibius obſerved that ſounds were produced from the compreſſion and concuſſion of the air, he firſt made uſe of that principle in contriving hydraulic organs; alſo water-forcers, automatons, lever and turning machines, and many others of the entertaining kind: and from this likewiſe he deviſed the conſtruction of water dials.

And firſt he fixed a tube made of gold, or of a gem perforated; becauſe theſe neither wear by the friction of the water, nor produce dirt to cauſe obſtructions. The water flowing equally through this tube, raiſes an inverted bowl, called by the artificers the *phellos* (the cork), or the *tympanum*; to which are connected a ruler, and wheels, with teeth made exactly equal. Theſe teeth impelling others, cauſe regular revolutions and motions: for other rulers, and other wheels, in the ſame manner indented, are by this ſingle motion actuated ſo as to produce various rotations and movements; by which images are put in motion; metæ are turned round; ſtones, or ovæ,[2*] are rejected; trumpets are ſounded; and other devices diſplayed. In this alſo, either on columns or pilaſters, the hours are marked; which an image riſing from the bottom ſhews with a wand, during the whole day, the ſhortneſs or length of which is daily and monthly adjuſted by adding or removing of wedges.

The ſtoppers of the water, which are to regulate its motion, are thus formed: Two metæ, one convex, the other concave, are by means of a turning machine made ſo exactly, that one may juſt go into the other. The regulator, by drawing theſe apart, or preſſing them together, increaſes or abates the influx of water in the veſſel. Upon this principle the water dials for winter uſe are conſtructed. If the cloſing or removing of the wedges ſhould not correſpond with the decreaſe or increaſe of the days (for the wedges are oftentimes made imperfect), it muſt be thus ordered: On the column, the hours taken from the analemna are

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(2*) This word is written *tonæ* in the printed editions, but is by ſeveral of the commentators corrected to *ovæ*, as it is alſo written in many manuſcripts; I have found it ſo in four out of five that I have examined: it is ſuppoſed to ſignify ſmall ſtones of an oval form, as *calculi* may have been the common term to ſignify ſuch as were globular, called by us *marbles*. At the 14th chapter of the following book, Vitruvius uſes the words *calculi rotundi*. Theſe ſtones were probably uſed to denote the hour of the day, by being thrown from the dial into a vaſe or bell.

to be tranſverſely deſcribed, and the lines of the months marked; the column alſo is to be made verſatile, ſo that by always turning the column to the wand of the image, which wand, as the image aſcends, ſhews the hours, it may determine, according to the reſpective months, the ſhortneſs and length of the hours.

Other kinds of water dials, which are called *anaporica*, are alſo made in this manner: The hours taken from the analemna are marked on rods of braſs, diſpoſed in the front from the center. On theſe are circumſcribed circles, bounding the ſpaces of the months. Behind the rods, a tympanum (a wheel) is placed, in which is deſcribed and painted the circle of the Zodiac, with the figures of the twelve ſigns; formed from the center, according to the ſpace of each ſign, one being greater, another leſs. Behind and to the middle part of the tympanum is fixed a verſatile axis; and about this axis a pliable braſs chain is wound, to one end of which hangs a phellos or tympanum, that is raiſed by the water; and to the other end a counterpoiſe of ſand, equal in weight to the phellos. Thus, as much as the phellos is raiſed by the water, ſo much the weight of ſand deſcending turns the axis, and the axis the tympanum; the rotation of which tympanum cauſes ſometimes the greater part of the circle of the Zodiac, at other times the leſſer, to be in motion, thus adjuſting the length of the hours according to the ſeaſons. In the ſeveral ſigns are made holes, correſponding to the number of days in the month, by which the bulla (index), that in dials repreſents the image of the Sun, ſhews the lengths of the hours, and moving from hole to hole, completes its courſe in the paſſing month. Thus as the Sun, traverſing the circuit of the ſigns, lengthens and ſhortens the days and hours, ſo the bulla in dials, by its point paſſing contrary to the rotation of the middle of the tympanum, if daily transferred, ſhews the hours and days within the repreſented limits of the months, ſometimes by a larger, and ſometimes by a ſmaller ſpace.

The management of the water, and the regulation of it for the operation, is done thus: Behind the front of the dial, inwardly, is placed a caſtellum (a ciſtern), into which a pipe conveys the water, and at the bottom is a cavity: to this is fixed a braſs tympanum, having a hole, through which the water from the caſtellum flows into it. In this a leſſer tympanum is included, with the joints exactly turned, maſculine and feminine, united together; ſo that the leſſer tympanum may, like a ſtopple, fit cloſely in the greater, and yet be turned eaſily. On the lip of the greater tympanum are made 355 points at equal diſtances; and on the circumference of the leſſer orbicule (or tympanum) is a fixed tongue, whoſe tip directs to the place of the points. Then in this orbicule is a hole juſtly proportioned, which the water in the tympanum runs through, and ſerves the work.

The repreſentations of the celeſtial ſigns are deſcribed on the lip of the greater tympanum, which is immoveable; and at the top is the ſign of Cancer: perpendicular thereto, at the

bottom, Capricorn; on the right of the ſpectator, Libra; on the left, Aries: and the other ſigns are diſpoſed between them, in the order they are ſeen in the heavens. Then when the Sun is in the orbicule of Capricorn,[4*] the tongue being at the part of Capricorn in the greater tympanum, daily touching the ſeveral points, having perpendicularly the great weight of the running water; this (water) forces with velocity through the hole of the orbicule into the vaſe then receiving it: being therefore ſooner filled, it diminiſhes and contracts the lengths of the days and hours. When by the daily rotation the tongue enters into Aquarius of the greater[5*] tympanum, the holes entirely deſcend (depart) from the perpendicular; and the violent courſe of the water being reſtrained, the orifice diſcharges more ſlowly: ſo that, as the vaſe receives the water leſs rapidly, it increaſes the lengths of the hours. From the points of Aquarius and of Piſces, when, in aſcending the degrees, the hole of the orbicule is an eighth part in Aries, the water then flowing moderately to the orifice, produces the equinoctial hours.

From Aries, paſſing through the places of Taurus and Gemini,[6*] to the higheſt point, the eighth part of Cancer, the hole or tympanum continuing to revolve, and arriving at the ſum-

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(4*) "Igitur cum ſol fuerit in *Capricorni orbiculo*, "lingula in majoris tympani parte," is as it is written in the editions of the text, which bears the tranſlation I have given. But I believe it ſhould be *Capricorno*, *orbiculi*, &c. interchanging the terminations of the words *Capricorni* and *orbiculo*, and placing the comma after the former; then, inſtead of the preſent reading in the tranſlation, it will be—"when the Sun is in Capricorn, the "tongue of the orbicule, &c." For Vitruvius has before called the leſſer tympanum, which has the tongue, by the name of *orbicule:* and it ſeems more probable that the ſame appellation is here applied to the ſame thing, than that it ſhould be given to the ſign of Capricorn, which is but a portion of a circle, and therefore not ſuited to the term, *orbicule* implying an entire circle.

(5*) In all the tranſlations, the word *majoris* in this place is rendered *minoris*; but unneceſſarily, as I believe. The tranſlators allege that "Vitruvius has before ſaid "that the greater tympanum was immoveable, and yet "that it is ſpoken of as moving." This ſeems to me not to be the fact, and that the paſſage may be underſtood in the manner I have rendered it.

The following part of this paſſage is probably alſo miſconſtrued: "Cuncta deſcendunt foramina perpendiculo, "& aquæ vehementi curſu cogitur tardius emittere ſalien-"tem." This is made to ſignify (except in Perault's free tranſlation), "all the holes fall perpendicularly, and "by the violent courſe of the water the pipe diſcharges "more ſlowly;" which is a ſenſe directly contrary to the effect of the mechaniſm, as deſcribed in the other ſentences: for they expreſs that the more violent courſe of the water cauſes the pipe to diſcharge faſter.

Cogitur is here I think to be underſtood in the ſenſe of checking or reſtraining the force of the water; and in that ſenſe the paſſage will agree with the context, and ſignify that the courſe of the water is made leſs violent by the place of the hole being changed; and for that reaſon the orifice diſcharges ſlower.

The word *deſcendunt* however may be an error, and written inſtead of *diſcedunt*, as Philander ſuggeſts; for the holes cannot be ſaid to deſcend, the tongue and hole of the leſſer tympanum being already at the loweſt point, and in moving from thence muſt aſcend, as Vitruvius expreſſes in the next ſentence (*gradibus ſcandens*): but the holes by that motion may be ſaid to *depart* from being perpendicular to each other; and this the word *diſcedunt* will ſignify.

(6*) It may be uſeful to mention as a caution, that in Perault's tranſlation all the words relative to the equinox of Aries, and the ſigns Taurus and Gemini, are omitted.

mit, the power relents, and flowing more ſlowly, enlarges the ſpaces, and produces in the ſign of Cancer the ſolſtitial hours. Deſcending from Cancer, through Leo and Virgo, to the point at the eighth part of Libra, it gradually leſſens the times, and contracts the hours; and thus arriving at the points of Libra, cauſes again the equinoctial hours. The hole ſtill paſſing downward through the tracts of Scorpio and Sagittarius, returns again to the eighth part of Capricorn, when, by the celerity of the ſtream, the ſhortneſs of the winter hours is produced.

The apparatus and methods uſed in the conſtruction of dials, I have deſcribed as well as I have been able. It now remains to treat of machines, and their principles; of theſe therefore, that the entire ſyſtem of Architecture may be completed, I ſhall write in the following book.

END OF THE NINTH BOOK.

THE

ARCHITECTURE

OF

M·VITRUVIUS·POLLIO.

BOOK THE TENTH.

PROEM.

IN that large and noble city of the Greeks, Epheſus, an old law, it is ſaid, was eſtabliſhed by the antients; of which the conditions were ſevere, but not unjuſt: for the architect, when he received the charge of a public building, was obliged to deliver an eſtimate of the expence, and aſſign over his goods to the magiſtrates, till the work ſhould be completed. This done, when the expence agreed with the eſtimate, he was rewarded with decrees and honours; alſo, if no greater ſum than a fourth part more was expended in the work, it was added to the eſtimate, and ſupplied by the public; nor was any penalty incurred: but when more than a fourth was expended, his goods were ſeized, to make up the ſum. I wiſh, to the immortal Gods, that this law were eſtabliſhed among the Roman people, not only in public, but alſo in private edifices, that the unſkilful might not commit impoſitions with impunity: for thoſe only who are ſkilled in the knowledge of the art, and are without doubt really profeſſors of architecture, ſhould be employed; nor be ſuffered to lead fathers of families into profuſe expences, but be driven from among the good: and that architects themſelves, from the fear of loſing their property, might be obliged to be more careful in making their eſtimates; ſo that proprietors might, with what they had prepared, or a little more, diſcharge the coſt of the building. For thoſe who can provide four hundred, will cheerfully add

another hundred: but if they be encumbered with the addition of one half, or more, they loſe hopes; and becoming diſpirited with the expence, and loſs of their property, are forced to deſiſt.[1*]

Nor does this happen in buildings only, but alſo in the works for the ſhows that are given by the magiſtrates, of gladiators in the forum, and of plays in the theatres: in which neither hindrances nor delays can be allowed for, but they muſt neceſſarily be finiſhed within the limited time. Such are the ſeats[2*] of the ſpectatory; the extenſion of the vela; and all thoſe things which, according to the uſage of theatres, are prepared for the machinery of the public ſpectacles. In theſe works, great judgment and ingenuity are required; for they cannot be accompliſhed without mechanical inventions, and the knowledge of various ſciences. As theſe therefore are eſtabliſhed, and in uſe, it ſeems not foreign to the purpoſe, before other ſubjects are begun, to explain accurately their principles.

Since therefore neither law nor cuſtom enforces this obligation, and the prætors and ediles muſt every year prepare machines for the games; it ſeems to me, O Emperor, not improper, as I have in the former books treated of buildings, to treat in this, which finiſhes the whole work, the precepts and eſtabliſhed principles of machines.

(1*) Galiani obſerves that, if there was occaſion to wiſh for ſuch a law at Rome in Vitruvius's time, much more ſhould they now wiſh for ſuch a one at Naples; where every one who builds finds himſelf cheated, and the eſtimate exceeded not only by a quarter or half, but by double or quadruple. This ſeems to be a very general caſe; it is indeed highly probable that a building will in all caſes exceed the eſtimate previouſly made of it, although done with all poſſible exactneſs and circumſpection; for it may not be poſſible to foreſee every circumſtance that will occaſion expence: and wherever a great number of men are employed, accidents, miſtakes, and inadvertences, will happen, which it is impoſſible to foreſee, or prevent: and ſometimes even the alterations of the inclination in the proprietor may operate to occaſion an increaſe of expence beyond what was firſt calculated; as well as diſhoneſty, and a predeterminate intention to deceive, in the workmen.

(2*) At note 8, ch. 6, b. 5, it is remarked, that Vitruvius there alluded to ſome kind of coverings that were laid upon the ſtone degrees of the theatres, at the times the games were performing. The word *ſedes*, ſeats, in this paſſage, I ſuppoſe to ſignify thoſe coverings which were of boards, mattraſſes, &c. and were probably provided, or at leaſt fixed upon the degrees, by the workmen (according to an eſtimate) every time the theatre was uſed. That ſome temporary kind of ſeats are here meant, is evident from their being mentioned with the *vela*, which was a temporary awning ſpread over the *ſpectaculum* (or part where the ſpectators ſat), as a ſhelter from the weather during the performance. Perault and Galiani, prepoſſeſſed with the opinion that Vitruvius lived before the time ſuch coverings became in uſe, endeavour to reconcile this paſſage to their ideas. Perault, however, admits that ſome temporary ſeats muſt be here meant by the words *ſedes ſpectaculorum*. Galiani ſuppoſes they ſignify an entire temporary wooden theatre, or the degrees of one, built in ſome forum, &c.; an idea which the ſenſe and purport of the paſſage will not admit: for Vitruvius oppoſes them to buildings, by ſaying falſe eſtimates are given in thoſe things as well as in buildings.

On the firſt diſcovery of the theatre of Herculaneum in Italy, the degrees were found to be covered with wood, according to the account of the Marquis di Venuti, who ſays the ſaid degrees appeared like a wooden ſtaircaſe, but too high for ſtairs.

CHAPTER I.

Of Machines and Inſtruments, and of their Origin and Uſe.

A MACHINE is a compoſition of timber, its uſe being chiefly for moving of great weights.[1*] It is moved by the ſkilful rotation of circles, which the Greeks call *cyclicen cineſin*. One kind of theſe is called *ſcanſorium*, which by the Greeks is called *acrobaticon*; another, *ſpiritale*, which they call *pneumaticon*; and a third, *tractorium*, which the Greeks call *banauſon*.

The Scanſoria are machines ſo contrived, that beams being erected, and tranſverſe pieces bound thereto, they may without danger be aſcended, for the purpoſe of reconnoitring.[2*]

The Spiritalia are thoſe in which the preſſure of the air gives the impulſe, and by which motions and organical ſounds are produced. The Tractoria are thoſe by means of which weights are drawn forward, or are raiſed aloft. The practice of the Scanſoria depends not ſo much on art as on courage. Theſe machines are ſecured with chains, tranſverſes, platted ligatures, and ſupporting props. In thoſe in which the power of the air is uſed, the effect is

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(1*) This is, as Perault obſerves, an imperfect definition of a machine, which may undoubtedly be made of any materials. But it is to be underſtood as an explanation of what Vitruvius means by the word *machine*, and allowance made for the ideas of the times.

(2*) The meaning of the words *ad apparatus ſpectationem*, which I have tranſlated for the purpoſe of reconnoitring, is conteſted. Barbaro, Perrault, and I, agree in opinion: but Galiani thinks the words ſignify, that theſe machines were to raiſe men aloft, for the purpoſe of viewing the public games and ſpectacles; which opinion ſeems improbable, as the antients had regular theatres for that purpoſe; and it is not likely that a number of people, aſſembled on thoſe occaſions, ſhould be raiſed on machines, that (Vitruvius ſays) were only ſecured with chains and ropes: theſe indeed would be ſufficient to ſupport one or two ſoldiers to reconnoitre and look over the walls of a beſieged town. At the 19th chapter of this book, Vitruvius mentions the aſcending machine *(aſcendentem machinam)* as one of thoſe machines of war that raiſed men from the ground to the top of the enemies walls. And, at the 22d chapter, ſpies are called *ſpeculatores—cum a ſpeculatoribus*.

Vegetius alſo, l. iv. c. 21, deſcribes a machine by the name of *tolleno*, for a ſimilar purpoſe, nearly agreeing with this in deſcription. Apollodorus and Heron, treating of machines, deſcribe that uſed for overlooking the enemies walls, which exactly anſwers to the idea Vitruvius gives.

It appears therefore probable that the *ſcanſoria* were thoſe machines that were uſed for reconnoitring beſieged towns; and not for the purpoſe of viewing the public ſhows and ſpectacles, as Galiani imagines.

obtained by the ſubtilties of art. The Tractoria, however, have greater and more extenſive uſes; and if managed with ſkill have the greateſt power. Of theſe, ſome are moved mechanically and others organically.

Between machines and inſtruments (organa) there ſeems to be this difference: machines are made to produce their effect by means of many operations, or by greater forces, like the baliſtæ, and ſcrewing preſſes; whereas inſtruments, if judiciouſly managed, with one operation perform the intention, as in the ſcorpions, or the rotations of aniſocycles.[3*] Both inſtruments and machines are uſeful, and without them no work can be expedited. All mechaniſm is derived from Nature, and eſtabliſhed by that governeſs and miſtreſs of the world, in the revolutions thereof. This we may chiefly obſerve and admire in the continual courſe of the Sun, of the Moon, and alſo of the five planets; which unleſs they were mechanically moved around, we ſhould neither have the earth illuminated, nor the fruits thereof ripened. The antients obſerving this, took example from Nature, and imitating thoſe divine works, contrived the conveniences of life; ſome therefore invented machines, and others inſtruments, that by their action works might be more expeditiouſly performed: and as theſe were found to be uſeful, by ſtudy, practice, and precepts they were gradually improved.

Let us reflect on the firſt invention neceſſary to life—clothing; how from the working the organical looms, which connect the warp with the woof, the body is not only preſerved by the covering thereby made, but alſo is ornamented, and even acquires additional dignity. We ſhould not have ſuch plenty of food, unleſs the yoke and the plough for oxen, and other beaſts, had been invented; and without the aſſiſtance of windlaſſes, preſſes, and levers, we could not enjoy the ſweetneſs of oil, nor the fruit of the vine; neither could theſe be conveyed, unleſs the machines of carts and waggons for land, and boats for water carriage, had been invented. Scales alſo, and balances, for the examination of the weights of bodies, ſecure us from injuſtice in the tranſactions of life.

There are innumerable machines of which it is unneceſſary to diſcourſe; becauſe they are

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(3*) What inſtruments or machines are meant by aniſocycles, is not known: the literal ſignification of the word is, unequal circles; whence they are generally ſuppoſed to be machines of the cochlea or ſpiral form, perhaps ſcrews. The diſtinction that Vitruvius makes between machines and organs, is here expreſſed by machines and inſtruments; the word *organ* in our language having become chiefly applicable to the muſical wind inſtrument of that name. *Utenſil* I once thought would ſuit the deſcription, but I found it would not ſo well agree with the term in other paſſages, as in the 9th chapter following.

daily at hand; ſuch are the Smith's Bellows, the Rotæ, Rhedæ, Ciſiæ, Torni[4*], and others that are in common uſe: we ſhall therefore begin to explain thoſe only which rarely come to hand, that they alſo may be known.

C H A P T E R II.

Of Tractorial Machines.

Fig. LXXI. WE will firſt begin with thoſe that are prepared for the erection of temples and public edifices, which are thus made: Three beams (*AAA*), proportional to the greatneſs of the weight to be raiſed, are provided; at the top they are joined together with a *fibula*[1*] (*B*), and are erected diverging at the bottom; being by ropes tied at the top, and diſpoſed about, kept upright. A *trochlea*[2*] (*C*), which ſome call *rechamus*, is faſtened to the top; in the trochlea are two pulleys[3*] (*a a*) turning on an axis: through the upper pulley the drawing rope is paſſed; then it deſcends, and paſſes round the under pulley of an inferior trochlea, and returns to the under pulley of the ſuperior trochlea; when it deſcends to the inferior, and in a hole therein the end of the rope is fixed; the other end of the rope paſſes to the bottom of the machine. On the hinder face of the beams, at the place where they diverge, are fixed *chelons*[4*] (*E E*), in which the ends of a windlaſs (*F*) are inſerted, ſo as to turn eaſily on its axis:

(4*) Theſe are alſo the names of machines with which we are now unacquainted, wherefore I have given the originals without attempting to tranſlate them. Rotæ are ſuppoſed to be ſome kind of machines acting chiefly by wheels. Rhedæ and Ciſiæ were a ſort of vehicles or chariots; the latter are ſaid to have had no more than two wheels. The Torni were turners wheels or lathes.

(1*) *Fibula* probably here ſignifies a bolt, pin, or ſcrew (*B*), put through the upper ends of the three beams.

(2*) A *trochlea* is that which we call a block or ſheaf, which is the caſe containing a ſet of pulleys.

(3*) It appears by the deſcription that the pulleys were placed under one another in the antient ſheafs; in ours they are generally placed by the ſide of each other, and turn on one and the ſame axis. It is to be obſerved, that this machine is repreſented by *Fig. LXXI.* in the ſtate of being raiſed, as deſcribed in the next chapter.

(4*) We have no term to expreſs the *chelons*, which are the ſockets or collars (*E*) fixed to the beams to receive the axis of the windlaſs. I find this word written *helonia*, *chelonia*, and *celonia*, in different manuſcripts.

the windlaſs has two holes near the ends, adjuſted to receive the levers (*G G*). To the lower rechamus alſo iron *forceps* (*H*, *Fig. LXXV.*) are faſtened,[5*] the teeth of which are fitted to holes in the ſtone: then when the end of the rope is fixed to the windlaſs, and the levers turn it, the rope winding itſelf round the windlaſs is diſtended, and thus raiſes the weight to the height and place of the work.

CHAPTER III.

Of the different Names of theſe Machines, and how they are erected.[1*]

A MACHINE on this principle, which is worked by three pulleys, is called *triſpaſtos*; but when there are two pulleys turning in the lower trochlea, and three in the higher, it is called *pentaſpaſton*. If machines are to be prepared for greater weights, beams of greater lengths and thickneſſes muſt be uſed; the fibula at the top, and the windlaſs at the bottom, being applied in the ſame manner.

(5*) The text has *forfices*; but Philander thinks it ſhould be read *forcipes*, ſignifying ſome machine of the pincer kind, which it is ſuppoſed the antients uſed to take hold of the ſtone. The inſtrument now generally uſed for that purpoſe is not of the forceps or pincer kind, but of a conſtruction more ſecure and more convenient; it is called by us *louis*, by the French *louve*, and is repreſented by *Fig. LXXII.* and *Fig. LXXIII.*

Another kind of theſe inſtruments, uſed in France, ſeems to be yet more ſimple and expeditious, but not quite ſo ſafe, in caſe the rope ſhould by any accident be ſlackened: it is repreſented by *Fig. LXXIV.* Piraneſi, in the third volume of his Antichita Romana, aſſerts that he found in ſome of the antient buildings ſtones that had holes cut in their upper ſurfaces, in ſuch a form as to ſuit the dovetail ſhape of the modern louis; and from thence ſuppoſes that the antients were acquainted with that machine.

(1*) Galiani, who has altered the titles of many of the chapters, has changed the title of this to "De alia machina "tractoria"—"another drawing machine," which appears to be an erroneous alteration; for Vitruvius is evidently not treating of another, but of the ſame kind of machines that he ſpoke of in the preceding chapter: he here only mentions their names, and how they are elevated. Galiani has probably been led into this miſtake by the erroneous ſeparation of this from the foregoing chapter.

Fig. LXXI. Theſe being explained, the ropes called *antarii*[2*] are looſely placed in the fore part; the *retinacula*[3*] (*I*) are diſpoſed at length over the ſhoulders of the machine, and, if there be no place where they can be faſtened, poſts (*K*) are put ſlanting into the ground, and well rammed around, to which the ropes are tied. A trochlea (*C*) is then bound with ropes to the head of the machine, and therefrom a rope is continued to a poſt (*K*), where it is put round the pulley of a trochlea (*L*) that is tied to the poſt, and from thence is referred to that trochlea (*C*) which is at the head of the machine; where, winding round the pulley, the rope deſcends from the top, and paſſes to the windlaſs (*F*) at the bottom of the machine, and is there faſtened. The windlaſs being then forced round by the levers, the machine without any danger raiſes itſelf. Thus by the diſpoſition of the ropes, and joining the retinacula to the poſts, the machine is in a proper manner adjuſted; the trochlea and drawing rope being applied as above written.

CHAPTER IV.

Of a ſimilar Machine of greater Power.

Fig. LXXV. BUT if a larger and more ponderous maſs be to be raiſed, windlaſſes are not to be truſted; but in the ſame manner as the windlaſs is retained in the chelons, ſo is an axis to be inſerted, having in the middle a large tympanum (*M*), which ſome call *rota*, but which the Greeks call *amphireuſin*, and others *peritrochon*.

In theſe machines the trochleas are not prepared in the ſame, but in a different manner, having at the bottom and at the top a double row of pulleys: the drawing rope being paſſed through the hole of the lower trochlea (*L*), ſo that the two ends of the rope, when extended,

(2*) The commentators are not agreed on the meaning of the word *antarii*, or what ropes it ſignifies: ſome ſuppoſe it to be an error, and ſhould be written *ductarii*; to which Galiani has altered it, thereby making it ſignify the ropes that draw up the weight, which it probably does. But I find it written *antarii* in five manuſcripts that I have conſulted: I have therefore retained it, as it may have been the common name of thoſe ropes at that time.

(3*) The *retinacula* are thoſe ropes which are uſed to ſuſtain the machine erect, and prevent its being forced from its poſition by the weights it draws or raiſes; theſe ropes extend in various directions from the head of the machine, and are faſtened at the other end to ſtakes driven into the ground, or to any other object that may happen to be properly ſituated, and be ſufficient for that purpoſe.

may be equal, it is there to be bound and connected with cords to the lower trochlea; and both parts of the rope ſo faſtened, that neither the right nor the left part may eſcape. Then the ends of the rope are carried to the outward ſide of the higher trochlea (*c*), and thrown round the under pulleys (*d*): returning then to the bottom, they are paſſed round the pulleys of the lower trochlea (*L*) on the inner ſide, and thence carried on the right and left to the top of the upper pulleys (*e*) of the higher trochlea; and, being thrown over from the outer ſide, are referred to the axis on the right and left of the tympanum, where they are ſecurely fixed.

Then winding another rope round the tympanum, it is continued to the capſtan (*N*), which by its motion turning the tympanum and axis, the ropes that are faſtened to the axis are by theſe means extended; and thus the weight (*O*) is gently, and without danger, elevated. But if a larger tympanum be placed either in the middle or at one end, without having a capſtan, the work may be more expeditiouſly performed, by the walking of men therein.

CHAPTER V.

Of another Kind of Tractorial Machine.

Fig. LXXVI. THERE is another kind of machine, ingenious enough, and expeditious in uſe; but it cannot be truſted in the work, except to thoſe who are ſkilful. It is a beam (*A*) that is erected and held by retinacula (*I*) four different ways: below the retinacula two chelons (*E*) are fixed; a trochlea (*C*) is bound with ropes upon the chelons; under the trochlea is put a ruler (*D*) about two feet long, ſix digits broad, and four thick.[1*] The trochleas have three rows of pulleys in breadth[2*]; ſo that three drawing ropes are bound to the top of the machine: theſe are carried to the lower trochlea (*L*), and thrown over its upper pulleys from the inner ſide; then referred to the higher trochlea (*C*), and thrown round its under pulleys from the outer to the inner ſide, when they deſcend to the lower (trochlea); and paſſing

(1*) The uſe of this *ruler* is not explained by Vitruvius; but it probably is to ſupport the upper trochlea at a little diſtance from the *beam*, ſo as to admit the pulleys to revolve eaſily, and alſo to give room for the drawing ropes to paſs between the trochlea and the beam.

(2*) It appears by the deſcription that the trochleas of this machine have three rows of pulleys in height, as well as three in breadth.

round the ſecond range of pulleys from the inner to the outer ſide, they are carried to the ſecond range of pulleys of the higher (trochlea), which paſſing over, they return to the loweſt: from the loweſt they are carried to the upper; and paſſing round the uppermoſt (pulleys), return to the bottom of the machine.

At the root of the machine is placed a third trochlea (*P*), which is called by the Greeks *epagonta*; by us, *artemon*. This trochlea is bound to the foot of the machine, and has three pulleys, around which the ropes paſſing, are conveyed thence to the men (*R*) who are to pull them; and ſo by the power of three rows of men, the weight is, without a capſtan, quickly raiſed to the top. This kind of machine is called *polyſpaſton*,[3*] becauſe it has many pulleys, which produce facility and expedition. The uſing of one beam has this convenience, that the load may be put as much as you will either before or declining to the right or left ſide.

All the machines before deſcribed, are adapted not only to theſe purpoſes, but alſo to the loading and unloading of ſhips; ſome being diſpoſed erect, others horizontally in verſatile *carcheſia*;[4*] ſo likewiſe, without erecting beams, by a ſimilar management of ropes and trochleas on the plain ground, ſhips are drawn aſhore.

(3*) Our workmen alſo ſometimes make uſe of a machine ſimilar to this, being a long *beam* fixed at the bottom in a wheel, as its baſe; and having ſheaves of pulleys at the top, by which ſtones or timbers are raiſed to the height of the work.

As Perrault's figures of theſe machines appear to be accurate and intelligibly drawn, I have made uſe of them ſo far as they accord with my ideas, altering them only where I imagined they were miſconceived or erroneous.

(4*) Vitruvius ſpeaks of the *charcheſium*, at the laſt chapter of this book, as being a very ſimple machine, and uſually made by the ſoldiers themſelves. Some part at the top of a ſhip's maſt was called by the ſame appellation, as was alſo a particular kind of cup. It is ſuppoſed to have been an upright beam, with another lying horizontally acroſs the top, and moveable upon a hinge upward and downward, as well as having a horizontal motion around; by theſe motions therefore it could raiſe things from the ground, and then convey them to their intended ſituation.

The French *grue* is a machine of this kind, and is very ſerviceable in building, but is not uſed in this country. It may not therefore be uſeleſs to deſcribe it, and give a repreſentation thereof. *AB*, *Fig. LXXVII.* is a poſt ſupported by the ſtruts and frame *C*; on the pivot *A* reſts a long beam *DD*, fixed to the timbers *EE* and *FF*, and ſupported from them obliquely by braces *GG*. In the timbers *EE* and *FF* (each of which conſiſts of two pieces bolted together laterally) are cut round holes at *HH*, large enough to admit the poſt *AB*, which is cut cylindrically in thoſe places: by theſe means the whole triangular frame *FDF* reſts, and may be turned upon the pivot *A*, and is preſerved in its poſition by the timbers *EE* and *FF*, embracing the poſt at *HH*. From the timber *FF* hangs a cylindric wheel *I*, large and broad enough for two or three men to walk in it: around the axis *K* of which is wound a rope, which paſſing through the timber *FF* to a pulley at the end of the timber *E*, is carried to the upper end of the long beam *DD*; where paſſing round a pulley *D*, it deſcends, and is faſtened to the weight *L* to be raiſed. The men then, by walking in the wheel *I*, turn it, and wind the rope round the axis *K*, thereby raiſing the weight; which, when arrived at the height required, is, by turning the machine on the pivot *A*, conveyed to its place in the work.

Perrault has, in his tranſlation of Vitruvius, given an account of a machine to raiſe weights, that acts upon the principle of the *roller*, having (as he miſtakingly aſſerts) no friction: a model of it is kept in the cabinet of the King of France. It conſiſts of a long column *AB*, *Fig. LXXVIII.* reſting at bottom on a pivot *A*, and ſup-

CHAPTER VI.

Of Cteſiphon's ingenious Manner of conveying heavy Weights.

Fig. LXXIX. IT is not foreign to the purpoſe to explain the ingenious contrivance of Cteſiphon, who, when he wanted to convey the ſhafts of columns from the quarry to the Temple of Diana at Epheſus, being unwilling, on account of the greatneſs of the weight, and the ſoftneſs of the fields in the way, to truſt to carriages, or hazard the ſinking of the wheels, contrived thus: He combined and united four *triental*[1*] pieces of timber (*A B C D*); two (*A D*) interpoſed tranſverſely to two (*B C*) equal to the length of the ſhaft (of the column): at the ends (*A D*) of the (ſaid) ſhafts he inſerted iron *chodaces*, like dovetails, ported upright by the frame and braces *C C C*, and by paſſing through a hole at *D*. On the top of the column is fixed a tranſverſe timber *F E*, from each end of which hangs a rope *E G*, *B G*, and the lower end of this rope is wound about a roller *G G*. At one end, *H*, of this roller, is alſo fixed and wound around it another rope, the end of which depends from thence to the weight *I*, to which it is faſtened. At the other end of the roller is a large wheel *K K*, around which alſo a rope winds, and then falls to the men *L* on the ground. The men by this rope pulling the wheel round, cauſe the roller to roll itſelf upon the ropes *G B* and *G E*, and thus as it revolves it aſcends: at the ſame time the rope *H I*, with the weight at the end of it, is winding around the end *H* of the roller, and drawing up the weight; which therefore aſcends, by the double motion, with double the velocity of the roller. This double motion muſt be conſidered, and allowed for in the length of the cords; or elſe the roller may be made of a leſs diameter at the part *H*, ſo as to retard the aſcent of the weight. Alſo, as the two ropes *H* and *G* are continually approaching each other in the rotation, that approach muſt be allowed for in the length of the roller.

To obviate the objection, that in this machine part of the power is employed in raiſing the wheel and roller as well as the weight—at the end of the roller, next the wheel, is a ring *N*, from which a rope riſes to the end *F* of the tranſverſe piece *F E*, where, paſſing over a pulley, it is faſtened to a maſs of lead *M*, equal in weight to the wheel and roller; which by this means are counterpoized, and their weight prevented from acting againſt the moving power. But it muſt be obſerved that friction is thereby occaſioned both in the pulley *E* and ring *N*, ſo that the machine is not entirely without friction.

(1*) The word *triental*, which ſignifies the third part of any meaſure, probably alludes to the meaſure of a foot; but it is doubtful whether we are to underſtand by it a piece of timber that is a third of a foot broad and a third of a foot thick (which is properly the ninth part of a piece that is a foot ſquare), or a piece of timber that is an entire foot broad, and a third of a foot thick (which is truly a third part of a piece that is a foot ſquare). All the tranſlators of Vitruvius have underſtood it in the former ſenſe: and yet it is almoſt impoſſible to be ſo; for timbers of that ſmall ſcantling could not bear their own weight, at the length as they muſt have been; the length of the columns, according to Pliny, book 36, ch. 11, and conſequently the length of theſe timbers, being ſixty feet: they muſt in ſuch a length bend to the ground, if not break in the middle. Secondly, the pivot and gudgeon together (called here *chodaces* and *armillæ*) would require to be at leaſt the third of a foot in diameter, to have ſufficient

ſecured with lead, and fixed *armillæ* [2*] in the timbers to ſurround the chodaces; alſo at the ends he bound poles (*F*) of oak. The chodaces were ſo incloſed in the armillæ as to have room to revolve freely; ſo that when the oxen were put under, and made to draw, the ſhafts, by the chodaces turning in the armillæ, might revolve without ceaſing.

Fig. LXXX. All the ſhafts being thus carried, and the *epiſtyliums* being alſo to be conveyed, Metagenes, the ſon of Cteſiphon, applied this method of conveying the ſhafts to the tranſporting of the epiſtyliums [3*]: He made wheels (*AB*) of about twelve feet, and inſerted the end (*C*) of the epiſtyliums in the middle of the wheels, with chodaces and armillæ, in the ſame manner; ſo that, when the triental timbers were drawn by the oxen, the chodaces, being included in the armillæ, turned the wheels; and the epiſtyliums being, as the ſhafts were, like the axle of the wheels, they were without difficulty brought to the work. Examples of this are the cylinders with which they ſmoothen the walks in the paleſtras. But this could not have been done if the diſtance had not been ſmall; for from the quarries to the Temple it is not more than eight thouſand paces [4*]; nor is there any aſcent, but it is a continued plain field.

In our memory, when the baſe of a coloſſal ſtatue of Apollo in the Temple was broken by age, leſt the ſtatue ſhould fall, and be alſo broken, they contracted for a baſe to be cut from the ſame quarry. One Paconius undertook it. This baſe was twelve feet long, eight feet

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ſtrength for the purpoſe: conſequently they would occupy the whole breadth of the timber; or, allowing them to be a little ſmaller, they would occupy ſo much of the timber as to leave the remainder of it too weak for its uſe. Theſe conſiderations, therefore, oblige me to underſtand the word *triental* to ſignify a piece of timber that is a whole foot broad, and the third of a foot thick, which would then be no ſtronger than the ſervice required.

This obſervation may contribute to aſcertain the true meaning of this and ſimilar kind of words in other caſes.

(2*) The *chodaces* ſeem to be pivots or pins fixed in the center of the ends of the ſhaft, as axles; and the *armillæ* to be the gudgeons or goujons let in the timbers to receive the chodaces: the latter, it may concluded, were of a dovetail ſhape only in the part that entered the ſtone, the outer part being neceſſarily rounded that they might turn eaſily in the gudgeons.

(3*) Galiani has here tranſlated the word *epiſtylium* by *cornici*; and in his notes reproves Barbaro and Perrault for tranſlating it *architrave*: becauſe, he ſays, it is probable not only the architrave, but the frize and cornice alſo, were thus tranſported. But here, if Galiani means that the whole entablature, i. e. architrave, frize, and cornice, were carried together, he muſt be miſtaken; for, as the columns were 60 feet high, if the entablature was any thing near the uſual proportion, the wheels could not contain it: and, if he means that they were carried ſeparately, then the architrave may as well be mentioned as the cornice; and the word *epiſtylium* may ſignify the *architrave*, as it generally does. Indeed it moſt likely has that ſignification in this place; for the wheels could not contain the cornice alone, ſuppoſing it to be of the uſual proportion, and in one piece. Galiani therefore muſt be miſtaken in this reproof.

(4*) *Millia paſſuum octo—eight thouſand paces*—are the words written in all the manuſcripts and printed editions: but in Chandler's Aſian Travels, page 137, this paſſage is corrected to *millia pedum octo—eight thouſand feet*; which he found to be about the diſtance from the quarry on mount Prion to the ſite of the Temple.

broad, and ſix feet high; which Paconius, with confident boldneſs, would not convey as Metagenes had done, but upon the ſame principle conſtructed another kind of machine. He made wheels (*A B*) of about fifteen feet, and in theſe wheels incloſed the ends (*C*) of the ſtone. Then from wheel to wheel, in their circumferences around the ſtone, he fixed two inch ſpindles (*D*), ſo as not to be more than one foot aſunder: about the ſpindles he wound a rope (*E*); and the rope being joined to oxen that drew it, as it unrolled it cauſed the wheels to revolve: but he was not able to draw this in a right line; it always wandering to one ſide or the other, ſo as to require being drawn back again. Paconius therefore, by drawing and redrawing, conſumed ſo much money, that he could not defray the expence.[5*]

Fig. LXXXI.

(5*) Some advantage, however, this machine of Paconius had over that of Cteſiphon and Metagenes; it had no friction, being like a roller: and if two drawing ropes had been wound around the two ends, inſtead of one only in the middle, they would, as Perrault well obſerves, have cauſed it to move in the line of draught; otherwiſe, ſmall inequalities in the wheels, the irregularity of the road, or the drawing rope varying from the middle, would cauſe the machine to move out of the intended direction.

Another advantage of this machine is, that the moving power being applied at the circumference inſtead of at the center of the wheel, it had on that account double the power to overcome the obſtructions and impediments of the road, and might therefore be moved with more facility: but it had this diſadvantage attending it, that it was neceſſary frequently to ſtop and back the cattle in order to rewind the rope around it.—I differ from the other tranſlators in my idea of the machine. They have placed the wheels as far apart as the ſtone, which was 12 feet long, would admit: but as the ſpindles were no more than the ſixth part of a foot (ſextantales), they would have been too weak with that extent to have ſuſtained the preſſure of the drawing rope, or even their own weight. For this reaſon I ſuppoſe the wheels were placed nearer together; probably ſo near, that one quarter of the length of the ſtone projected beyond the wheel at each end, as I have ſhewn it by *Fig. LXXXI.* Thus each half of the ſtone was exactly poiſed on each wheel; and it was thus leſs liable to be broken by the accidents and concuſſions it might meet with on the road.

But, even at this diſtance of leſs than ſix feet, ſpindles of two inches appear to be too weak for the purpoſe (unleſs they were of iron, which we have no authority for ſuppoſing). Planks of that thickneſs were more ſuitable, and I have ſome ſuſpicion that planks ſhould be underſtood; eſpecially as the word *ſextantales* is uſed, which, from the arguments in a note preceeding, ſeems more expreſſive of pieces of a foot broad, and two inches thick, than ſpindles of two inches diameter. Such planks would not be ſtronger than ſufficient to bear the preſſure of the rope by which the cattle drew the machine.

CHAPTER VII.

Of the Diſcovery of the Quarry that produced the Stones for erecting the Temple of Diana at Epheſus.

I SHALL make a little digreſſion to relate how this quarry was diſcovered. A ſhepherd named Pixodorus frequently wandered about the place: and at the time when the citizens of Epheſus were conſidering of building the Temple of Diana with marble, and were debating whether to have that of Paros, Proconneſus, Heraclea, or Thaſos, Pixodorus drove his flock there to feed. It happened that two rams encountering miſſed each other; and one ſtruck his horn with violence againſt a ſtone, a ſhiver of which flying off, appeared to be exceedingly white. Pixodorus, it is ſaid, then left his ſheep in the mountains, and ran ſpeedily with the ſhiver to Epheſus, where he related the circumſtance. Upon this, honours were immediately decreed him; his name was changed from Pixodorus to Evangelus: and even at this day the magiſtrate goes every month to the place, and ſacrifices to him; being, if he omit it, liable to a penalty.

CHAPTER VIII.

Of the ſtraight and circular Motions of Machines for raiſing of Weights.

I HAVE briefly explained what I judged was neceſſary concerning tractorial machines, the movements and powers of which depend on two principles, different and diſſimilar from each other, but ſo agreeing, that the operation is perfected by both; one is rectilinearity, which the Greeks call *euthian*; and the other is circularity, which they call *cycloten*. But, in truth, neither the rectilinear motion without the circular, nor the circular motion without the rectilinear, can be effectual for raiſing of weights. This I ſhall explain, that it may be more intelligible.

The axles being fixed in the pulleys as centers, and placed in the trochleas, around theſe pulleys the ſtraight ropes are circumvolved; and the levers being inſerted in the ſucula, it is the rotation that cauſes the weight to aſcend. Of this ſucula, the axes, in the chelonia ſerving as centers, are rectilinear; and the levers put in the holes of it, being at their ends moved circularly in the manner of a wheel, occaſion by turning the riſing of the weight.

In like manner alſo, when an iron lever is applied to a weight that a multitude of hands cannot move, if under it, to ſerve as a center, a fulcrum, which the Greeks call *hypomochlion*, be laid,[1*] and the tongue of the lever be put under the weight, the ſtrength of one man, preſſing at the end thereof, will raiſe the weight. This happens becauſe the fore part of the lever, the ſhorteſt from the fulcrum, which is the center, is under the weight; and the longeſt part is from this center to its head, which being moved in a circular line, the preſſure of a few hands poiſes the great weight of the load. So likewiſe if the tongue of the iron lever be put under the load, and its head be not preſſed downward, but on the contrary be lifted upward, the tongue, ſupported by the ground, will have that as the load, and the angle of the ſame load for the fulcrum: thus by a contrary method, although not ſo eaſily as by the fulcrum, the load will be moved. But if the tongue of the lever, lying upon the fulcrum, be put too far under the load, and its head be nearer the center of preſſure (i. e. the fulcrum), the load cannot be raiſed; nor unleſs, as above written, the poiſing part of the lever be the fartheſt from the head, and not neareſt to the load.

This may be obſerved in the balances which are called *ſtateræ* (ſteelyards); for when the handle, ſerving for the center, is ſituated near the end from whence the ſcale hangs, and the equipoiſe is moved over the points on the other part of the ſhaft, which is the longeſt, or is even carried to the extremity, a ſmall weight becomes equal, and ſuffices to balance a very great one, by the counterpoiſe and poiſing part of the ſhaft being the fartheſt from the center; and thus the lighter weight of the counterpoiſe balancing the greater power of the load, gently, and without violence, forces it to riſe upward.

(1*) *Suppoſita uti centro cito porrecta preſſione.* Perrault remarks that *ſuppoſita* ſhould be read *impoſita*, ſignifying that the fulcrum, *porrecta preſſione*, ſhould be put *upon* inſtead of *under* the lever, in which he is certainly miſtaken: for as Vitruvius ſays the tongue of the lever is under the weight, the fulcrum muſt conſequently be under the lever; and this is ſufficiently evinced by the ſignification of the Greek word *hypomochlion* (under lever), as Galiani well obſerves. Vitruvius is here ſpeaking of that ſort of lever where the fulcrum is between the weight and the moving power at the head of the lever; and he preſently afterwards deſcribes the other ſort, where the weight is between the fulcrum and moving power.

Likewiſe a ſhip of great burthen is, by the ſteerſman preſſing ſkilfully the handle of the rudder, which the Greeks call *oiax*, turned with the ſtrength of one hand, it being upon the ſame principle of the center (or fulcrum); and this notwithſtanding it be laden with the weight of immenſe quantities of merchandize and proviſions. When the ſails alſo are hung at the middle of the height of the maſt, the ſhip cannot move ſwiftly; but when the *antennæ* (ſail yards) are drawn to the uppermoſt point, it then moves with greater celerity, becauſe the ſails are not near the foot of the maſt, which is the place of the center, but are far above, and receive the wind at a diſtance therefrom: for, as a lever put under a weight, if preſſed at the middle, is more difficult to be moved, but when preſſed at the head eaſily raiſes the weight; ſo it is with the ſails—if hung at a moderate height, they have leſs power; but if placed at the maſt head, at a diſtance from the center, with the ſame, not with greater wind, acting at the topmoſt point, they force the veſſel onward with more velocity. The oars alſo that are bound with thongs to the *ſcalmi* (oar pins), when they are impelled and pulled back again by the rowers, if their blades at the extremity in the ſea extend far from the center (of motion), they more violently force the veſſel forward, its prow cutting through the liquid body of the water.[2*]

(2*) Perrault diſputes with Vitruvius concerning this doctrine of the ſails and oars: He aſſerts that, whether the maſt of a veſſel be longer or ſhorter, or whether the ſails be put higher or lower, it affects not the motion of the veſſel; for as the whole of it moves together, and there is no fixed point to ſerve as a fulcrum or center of motion, it cannot be comparable to a lever, nor can it act as ſuch: that it is ſimply puſhed forward by the wind; and the only advantage of the ſails being higher, is, that the wind is there ſtronger: but that there is alſo a diſadvantage therein; for the head of the ſhip is by that means cauſed to plunge more in the water, and thereby its courſe will be more impeded.

Perrault denies alſo that the oars act as levers. To this latter ſubject Galiani has very well anſwered: but to the doctrine of the ſails he has not replied; he only ſays he could anſwer it, as he has done that relative to the oars.

A ſhip floating on the water may be compared to a ſuſpended balance; the body of the ſhip anſwers to the beam or arms of the balance, and the maſt to the perpendicular tongue or index fixed in the middle of the beam: now if any power be applied to the top of the index, ſo as to affect it horizontally, it cauſes it to incline forwards, and puts the beam out of its equilibrium; which to reſtore, either the top of the index muſt return again to its former place; or the bottom of it, with the beam, muſt move forward, ſo as to be perpendicular to the top: but if the top of the index be prevented from returning to its place by the continued preſſure of the power, and the beam be ſo ſuſpended that it can change its place (for inſtance, if it were ſuſpended on friction wheels, or on a cork floating in water), then the beam and bottom of the index will move forward to reſtore the equilibrium. Thus, in a ſhip, the power of the wind cauſes the maſt (by means of the ſails) to incline forward, by that means putting the body of the ſhip out of its equilibrium; and as the wind, by continuing its impulſe, prevents the top of the maſt from returning to its former place, the body of the ſhip is obliged, by its own gravity, to ſlide forward on the water, in order to recover the equilibrium: ſo that the wind continually impelling the maſt to incline forward thereby deſtroying the equilibrium, and the ſhip continually ſliding forward to recover that equilibrium, cauſe the uninterrupted progreſſion of the veſſel.

If this be the caſe, then the longer the maſt, or the higher the ſails, the leſs power will be required to incline the maſt, and put the ſhip out of its equilibrium; and conſequently the maſt acts in this reſpect as a lever, the place of the ſail being the manche or handle; the center of gravity of the veſſel being the fulcrum; and the reſiſtance of the veſſel to be put out of its equilibrium being the load. The maſt then in this caſe acts not as a lever in preſſing the ſhip forward, but in putting it out

When heavy loads are carried by phalanxes[3*] of ſix or four men, they are poiſed in the middle of the phalanx, ſo that an equal portion of the weight of the undivided load may bear upon the ſhoulders of each of the porters. Therefore the middle parts of the phalanxes, which ſecure the ſtraps of the porters, are lined with iron clamps, to prevent their ſliding from one ſide or the other: for, when they move out of the middle, they preſs too much upon the ſhoulder of him to whom they are neareſt; in the ſame manner as when, in weighing with the ſteelyard, the counterpoiſe is moved toward the end of the ſhaft.

On the ſame principle cattle, when their yokes are by the girths of their collars adjuſted in the middle, draw the load equally; and if their ſtrength be unequal, and the ſtrongeſt preſſes the other, putting forward the collar makes one part of the yoke the longer, which helps the weaker beaſt. It is the ſame in the phalanxes as in the yokes, when the ſtraps are not diſpoſed in the middle, but one ſide, to which the ſtrap is moved, becomes the

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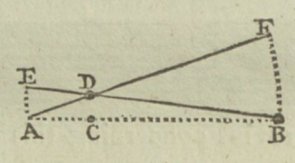
of its equilibrium, and thereby being the cauſe of its progreſſion forward; the immediate cauſe of which is its own gravity, and effort to regain its equilibrium, joined to the momentum it acquires in that action. The ſhip muſt alſo undoubtedly receive a conſiderable degree of velocity from the direct preſſure of the wind upon its hull, as Perrault aſſerts; but in this way it receives as much aid by its body as by the ſails.

With regard to the oars, Perrault maintains that "it is not upon the principle of a lever that the length of the oars contribute to the volocity of the veſſel: for in a lever it is required that the longeſt part from the fulcrum ſhould be that next to the agent or mover; whereas in the oar it is directly the contrary, the longeſt part being that toward the water."

There are two kinds of levers; one where the fulcrum is between the load and the agent, and the other where the load is between the fulcrum and the agent: the oar is of this latter kind; the veſſel is the load to be moved, the water and the rowers are interchangeably the agent and the fulcrum. It is equal in effect whether the water puſhes the oar againſt the rowers, or the rowers againſt the water, provided one is ſtrong enough to reſiſt the other as a fulcrum. Now if a ſtream of water run againſt the end of an oar, the longer that oar is, the greater effect the water muſt have upon it; and provided the rowers be ſtrong enough to withſtand the action as a fulcrum, then the oar muſt preſs more forcibly upon the ſide of the veſſel, and thus cauſe it to move quicker. It will be the ſame in effect if the rowers pull the oar againſt the water; for whether the rowers move their end of the oar from *E* to *A* (the end *B* being held at reſt by the reſiſtance of the water), or whether the water moves the other end of the oar from *F* to *B* (the rowers holding their end firm at *A*), the effect upon the veſſel at *D* will be the ſame; it will in both caſes be moved from *D* to *C*. It cannot be alleged that the oar never remains at one place in the water, but paſſes through it; for that may or may not be the caſe, according as the veſſel moves quicker or ſlower: it is alſo equal whether the water move againſt the oar, or the oar againſt the water.



From the above arguments it appears therefore that oars act on the principle of levers; and that the longer they are, the greater effect they muſt have on the veſſel, as Vitruvius aſſerts: but it always is ſuppoſed that the rowers muſt be more numerous, or ſtronger, in proportion as the oars are longer, to reſiſt the greater power that the water has by that means on the oars.

There can however be no doubt that, the longer the part of the oar next the rower may be, the eaſier it is for the rower to work it. But the ſhape of ſhips does not admit of ſuch a conſtruction; inſtead therefore of giving greater length to that part of the oar, the power is ſupplied by the greater number of the rowers.

(3*) The *phalanxes* here mentioned were machines for carrying burdens, ſupported on the ſhoulders of four or ſix men; thence called *tetraphori* and *hexaphori*.

ſhorter, and the other the longer, from the center; for if, upon the point from whence both parts of the ſtrap proceed, the ends be circumacted, the longer part will deſcribe a larger, and the ſhorter part a ſmaller circle. Thus, as ſmaller wheels are harder and more difficult to move,[4*] ſo the phalangæ and yokes, in thoſe parts that have the ſmalleſt diſtance from the center to the ends, preſs hardeſt on the ſhoulders, and in thoſe that have a greater ſpace from the ſame center, both in drawing and carrying, diminiſh the preſſure of the load.

As theſe receive their motion by rectilinearity and circularity, relative to a center; ſo likewiſe the Plauſtræ, Rhedæ, Tympana, Rotæ, Cochleæ, Scorpions, Baliſtæ, Prela, and other machines, in the ſame manner actuated by the rectilinear and circular motions, perform their intended effects.

CHAPTER IX.

Of the ſeveral Kinds of Machines for raiſing Water, and firſt of the Tympanum.

I SHALL[1*] now diſcourſe of the machines that are invented for raiſing of water, of various kinds are made; and firſt I ſhall ſpeak of the Tympanum: this does not raiſe the water high, but it diſcharges a great quantity in a little time.

(4*) Vitruvius here ſays that ſmaller wheels are more difficult to move than larger: but this muſt be underſtood conditionally, and not abſolutely; for if the plane on which they move, and their own ſurfaces, were perfectly ſmooth, then all wheels, large or ſmall, would move equally eaſy: or, if the axis and the obſtacles be in the ſame proportion to ſmall wheels as to larger, the effect will be the ſame when loaded with an equal weight; becauſe the levers by which they are moved are in proportion to the obſtructions and reſiſtances to their motion. Or, again, if we add to theſe conditions that there be no weight upon their axes, then large or ſmall wheels will be moved with equal facility, becauſe they in that caſe do not act as levers, but as rollers, puſhed or pulled onward by a force applied at their centers.

But as all wheels, as well as the planes on which they move, have numberleſs inequalities, and their axes are always preſſed with ſome weight, they muſt all have the obſtructions of the road and the friction of their axes to overcome; in doing which they act as levers, the radius or ſemidiameter of the wheel anſwering to the longer part of the lever from the fulcrum: ſo that ſmaller wheels, acting as ſhorter levers, muſt in general be more difficult to be moved.

(1*) Vitruvius's word is *organis*; but as that term would not ſuit the object in our language, it is rendered *machine*. See note 3, in the firſt chapter of this book.

Fig. LXXXII. An axis (*A*), either turned or worked round, is made, its ends being plated with iron, and having around it, in the middle, a *tympanum* (wheel) of boards (*B*)[2*] joined together; this is placed on poſts (*C*), having alſo plates of iron under the ends of the axis. In the cavity of this tympanum eight planks (*D*) are inſerted tranſverſely, touching both the axis and the circumference, which divide the tympanum into ſo many equal ſpaces. Upon the front of it alſo planks are fixed, leaving apertures (*E*) of half a foot, to let in the water; and at the axis *columbaria*[3*] are ſunk in the ſeveral ſpaces, ſo as to lead to one place. This, when pitched in the manner of ſhips, is turned by the walking of men[4*]; and receiving the water through the apertures (*E*), in the front of the tympanum, diſcharges it again through the columbaria at the axis: ſo that by placing thereunder a wooden trough (*F*), with a channel joined to it, the water is conducted to ſupply gardens, ſalt works, and various other uſes.

Fig. LXXXII. When water is to be raiſed higher, the ſame contrivance may be altered thus: A wheel (*B*) is made round an axis (*A*), of ſuch a magnitude as the height to which the water is to be raiſed, requires; around the extremity of the ſide of the wheel, ſquare buckets (*G*), cemented with pitch and wax, are fixed; ſo that, when the wheel is turned by the walking men, the filled buckets being raiſed to the top, and turning again toward the bottom, diſcharge of themſelves, what they have brought, into the reſervoir.

Fig. LXXXIII. But, if a place of a ſtill greater height be to be ſupplied, on the ſame axis (*A*) of a wheel (*B*) a double chain (*C*) of iron is wound, and let down to the level of the bottom, having braſs buckets (*D*), each containing a congius (ſeven pints), hanging thereto; ſo that, upon the turning of the wheel, the chain revolving round the axis, raiſes the buckets to the top; which, when drawn upon the axis, become inverted, and pour into the reſervoir (*E*) the water they have brought.

(2*) *Tympanum* here means *a hollow cylindric wheel*, ſo called from its being ſimilar to a tympanum or drum.

(3*) At book iv. chap. 2. the grooves or channels in which the timbers lie, are called *columbaria*; which gives us to underſtand that by this word is meant ſome kind of channels or grooves.

(4*) Vitruvius does not inform us where the men that turned this wheel by their walking were diſpoſed; they could not be within it, as in our warehouſe crane wheels, becauſe that part of this wheel is occupied by the water: Perrault therefore concludes that there muſt have been another wheel adjoined for that purpoſe, and repreſents it ſo in his engraving. But as Vitruvius deſcribes no ſuch additional wheel, which would be too important a part of the machine to be omitted in the deſcription, I am diſpoſed to believe that the operation was performed in ſome other manner: it might be done by men walking on the outſide or convex ſurface of the wheel, having rails erected to ſecure them from accidents, as I have ſhewn in my drawing, *Fig. LXXXII.* And this may have been the antient, although not the modern, method of working theſe machines.

CHAPTER X.

Of Wheels and Tympanums for grinding of Corn.

THE ſame kind of wheels as thoſe before written are alſo made in rivers. Around their fronts are affixed pinnæ (*A*), which, when impelled by the current of the river, force the wheel to revolve; and the buckets thus drawing up the water, diſcharge it at the top, without the operation of walking; the impulſe of the river itſelf performing the whole work. *Fig. LXXXIV.*

By the ſame means alſo the *hydraulæ*[1*] are turned; in which all the parts are the ſame, except that on one end of the axis they have a toothed tympanum (*B*) included[2*], which, by being ſet perpendicularly on the edge[3*], is turned equally with the wheel (*C*). Adjoining this tympanum a larger one[4*] (*D*), alſo toothed, is placed horizontally; *Fig. LXXXIV.*

(1*) *Hydraulæ* is altered by Salmaſius to *hydromylæ*, *water mills*; the former word may however have been uſed by the Romans, as the common name of all machines moved by water.

(2*) *Tympanum dentatum & incluſum.*—Perrault objects to this phraſe, as expreſſing that the tympanum was included within the axis, inſtead of the latter being included in the former: but it is evident Vitruvius means as he has expreſſed it; for he uſes the ſame expreſſion again in this chapter, and I imagine it is to be underſtood to ſignify that the tympanum is included within the extent of the length, not within the body, of the axis. The ſame expreſſion is again repeated at the 14th chapter following, where it is evidently uſed in this ſenſe.

(3*) The words are, *in cultrum*, on the knife; a mode of expreſſion uſed to ſignify the being ſituated on the ſide or edge: and *a coltello* is at this day uſed by the Italians in the ſame ſenſe.

(4*) *Secundum id tympanum majus item, &c.*—*Majus* (larger) is changed to *minus* (ſmaller) by Perrault and Galiani; for, ſay they, "unleſs this laſt-mentioned tympanum was ſmaller than the former, the mill-ſtone which was adjoined to it would move ſlower than the water wheel, which may be too ſlow to anſwer the purpoſe, and is contrary to the preſent practice."

All the manuſcripts that I have examined, as well as the printed editions, agree in having *majus*, and not *minus*: and we ought to be cautious of altering the text in paſſages where all the copies agree; the rather as the antient mills may have differed from the modern ones in this reſpect, and yet have performed their office as well. For, although by ſuch a conſtruction the mill-ſtone would be moved ſlower, it would however be moved eaſier, as being moved by a longer lever; or, if the water wheel ſhould have been ſmaller than ours, it would revolve quicker, and thus cauſe the mill-ſtone to revolve as quickly as ours does. Or, thirdly, if the mill-ſtone itſelf ſhould have been larger, its velocity at the circumference may have been greater than that of a ſmaller mill-ſtone whoſe revolutions were quicker, and alſo would have contained a greater quantity of grain under action at the ſame time; ſo that the intention might be as well executed by a mill of ſuch a conſtruction, as by thoſe in preſent uſe. For theſe reaſons it appears unneceſſary to follow the example of Perrault and Galiani in deviating from the text.

Perrault has repreſented the mill-ſtone wheel as being compoſed of ſpindles, inſtead of teeth, as Vitruvius deſcribes; becauſe, he ſays, they are ſo at preſent: as if it were not poſſible for the antient mills to be made different from thoſe of the moderns.

in this is contained an axis (*E*), having at its upper end an iron dovetail (*F*), which is inſerted in the mill-ſtone (*G*): thus the teeth of the tympanum (*B*), that is included on the axis, impelling the teeth of the horizontal tympanum (*D*), cauſe the rotation of the mill-ſtone, to which the ſuſpended hopper (*H*) (infundibulum) furniſhes the grain; and by the ſame rotation the meal is ejected.

CHAPTER XI.

Of the Cochlea.

Fig. LXXXV. and Fig. LXXXVI.

THERE is a machine of the *cochlea* kind, that draws a great quantity of water, but does not raiſe it ſo high as the wheels; it is conſtructed thus: A beam (*A*) is provided, being as many digits in thickneſs as it has feet in length; and this is made round. At the ends (*A*) the circle (*ACE*) is divided with compaſſes either into four quarters, or eight octants, drawing lines; and theſe lines are to be ſo diſpoſed, that when the beam is erected level on a plain, both ends of the (reſpective) lines (*AA, BB, CC, DD, EE*) may correſpond in the perpendicular. After this, from one end to the other tranſverſe lines (*F*) are drawn, in ſuch a manner that, whatever the meaſure (*AB*) of the eighth part of the round of the beam may be, ſo large muſt be the ſpace (*FF*) between them, latitudinally. Thus both circumferently and longitudinally the ſpaces will be equal; and theſe lines, at the places where they are deſcribed, paſſing thoſe that are lengthways, make interſections, and thoſe interſections are marked by points. This being exactly deſcribed, a thin ruler, cut from willow or agnus caſtus, being anointed with liquid pitch, is fixed at the firſt point of interſection (*A*), from whence it is laid obliquely to the next interſection (2) of the longitudinal and circumferent lines; and ſo circumvolving, and paſſing through every point (3, 4, 5) in order, it is applied to every interſection, till it arrives and is fixed at that line which is on the eighth point (8) from the firſt, wherein the prior part of it was fixed: thus, as much as it paſſes obliquely through the ſpaces and eight points, ſo much it advances toward the eighth point in longitude. In the ſame manner, through all the ſpaces of longitude and circumference, fixing rulers obliquely at every interſection, and winding through the eight diviſions of the thickneſs, they form channels, and an exact imitation of the natural cochlea. On the other tracts, other rulers, alſo anointed with liquid pitch, are fixed, and added till the whole thickneſs becomes equal to the eighth part of the length. Then upon theſe the planks (*G*) are

fixed around, which cover the ſpirals; the planks being ſaturated with pitch, and bound with iron hoops (*H*), that they may not be damaged by the action of the water. The ends of the beam are alſo armed with plates and nails of iron; and in theſe iron pivots (*I*) are fixed.

On the right and left of the cochlea, beams (*K*) are diſpoſed, having tranſverſe pieces (*L*) adjoined at both ends, in which iron ſockets (*I*) are inſerted, that receive the pivots; and then, by men walking (*M*), the cochlea is made to revolve. With regard to the erection of this machine, it muſt be diſpoſed in ſuch an inclination, that it may anſwer to that deſcribed in the right-angled triangle of Pythagoras, that is, the length being divided into five parts, the head of the cochlea (*I*) is elevated equal to three of thoſe parts; ſo that, from the perpendicular thereof to the lower holes, will be the ſpace of four parts. The manner in which this may be done, is ſhewn by the figure deſcribed at the end of the book.

Thus, concerning machines for raiſing water that are made of timber, the manner in which they are conſtructed, and from what powers they receive their movement, affording numerous conveniences by their rotations, I have, in order that they may be known, written as clearly as I have been able.[1*]

(1*) This is that famous machine univerſally known by the name of the Screw of Archimedes: it is not always made with eight or four channels, as Vitruvius deſcribes it; but varies in that reſpect, having three, two, and ſometimes but one channel: nor is the inclination of thoſe channels, with regard to the beam or cylinder, always the ſame. Vitruvius has deſcribed them to be in an angle of 45, but they may be in an angle either more or leſs than 45; and the nearer they approach to a right angle with the cylinder, the more the head of the cylinder may be elevated, and the higher the water will of courſe be raiſed. It is this inclination, and not the number of the channels, as Perrault aſſerts, on which depends the height the water may be raiſed to, with a machine of a given length; for all that is required to anſwer that purpoſe, is, that the channels ſhould have ſome declination from the level or plane of the horizon, that the water they receive may, as the cochlea turns, continually deſcend in its courſe. But, where there are many channels, they muſt be made narrower than where there are few, in order to preſerve the ſame inclination; ſo that leſs water will be raiſed by each revolution of the machine.

Vitruvius informs us that this machine is alſo turned by the walking or treading of men; but has not deſcribed the apparatus for this work, nor where or how it is performed. It cannot be well ſuppoſed that ſuch a wheel or tympanum, as is heretofore applied to the tractorial machines, could be annexed to this; for, on account of the inclined ſituation of the cylinder or cochlea, the men could not ſtand upright therein: wherefore I muſt ſuppoſe (as at the ninth chapter foregoing) that ſuch operation was done by the men walking on the convex part of a wheel affixed to the end of the cylinder, as ſhewn by *Fig. LXXXVI.*

CHAPTER XII.

Of the Machine of Cteſibius.

Fig. LXXXVII. IT remains now to deſcribe the machine of Cteſibius, which raiſes water very high. This is made of braſs: at the bottom a pair of buckets (*A*) are placed, at a little diſtance, having pipes (*B*) like the ſhape of a fork annexed, meeting in a baſin (*C*) in the middle. At the upper holes of the pipes, within the baſin, are made valves, hinged with a very exact joint; which, ſtopping the holes, prevent the efflux of the water that will be preſſed into the baſin by the air. Upon the baſin a cover (*D*), like an inverted funnel, is fitted, which is adjoined and faſtened to the baſin by a collar, rivetted through, that the preſſure of the water may not force it off; and on the top of it a pipe (*E*), called the tuba, is affixed perpendicularly. The buckets (*A*) have valves placed below the lower mouths of the pipes, and fixed over holes that are in their bottoms; then piſtons (*F*), turned very ſmooth, and anointed with oil, being incloſed in the buckets, are worked with bars and levers from above: the repeated motion of theſe, up and down, preſſing the air that is therein contained with the water, the holes being ſhut by the valves, forces and extrudes the water through the mouths of the pipes (*B*) into the baſin (*C*); from whence riſing to the cover (*D*), the air preſſes it upwards through the pipe (*E*); and thus from the low ſituation of the reſervoir raiſes it to ſupply the public fountains.

Nor is this the only one that has been invented by Cteſibius: there are many others, and of various kinds, which, by the means of fluids compreſſed by the force of the air, repreſent ſome natural actions; ſuch as the Merulæ, that, when put in motion, utter voices; and the Engibatæ,[1*] that move images, ſeeming to drink; and other acts, entertaining to the ſenſes of

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(1*) The hydraulic devices, called Merulæ and Engibatæ, are now unknown. The former is, from the name, conjectured to be an imitation of the ſhape and voice of a blackbird. The latter is by Barbaro ſuppoſed to come from the Greek word *engion, near:* but Baldus thinks it ſhould be written *angibata*, coming from the Greek word *angeion, a vaſe*; which explication Perrault has adopted, tranſlating the paſſage thus—"the little figures that are "made to move in glaſs vaſes, by means of the water "which the vaſes have received."

Perrault here applies the word *bibentia* to *engibata*, not to *ſigilla*; ſuppoſing, as he ſays, it is not meant that the images drink, but that it is the *engibatæ* or *vaſes* that receive the water. I however cannot be of his opinion, but agree in my tranſlation with Galiani.

ſeeing and hearing. From among theſe, thoſe that I have judged moſt uſeful and convenient I have ſelected and treated of in the foregoing book of dialling, and in this of the raiſing of water. The others, which are not for utility but for pleaſure, thoſe who are deſirous of knowing, may find in the Commentaries of Cteſibius.

CHAPTER XIII.

Of the Hydraulic Organs.

Fig. LXXXVIII. I MUST not omit to diſcourſe briefly, and as explicitly as I am able, on the conſtruction of the hydraulic organs.[1*] Upon a compact baſe (*A*) of timber an arca (ciſtern) *(B)*, made of braſs, is diſpoſed; and to the right and left, upon the baſe, timbers *(C)* united in the manner of ladders are erected; between theſe are included braſs buckets *(D)*, with moveable piſtons *(E)*, very exactly turned, and having bent and jointed irons *(F)* fixed to their middle, with levers *(G)* adjoined, and being covered with unſhorn ſheep ſkins: in the upper ſurface (of the buckets) are holes *(P)* of about three digits; near to which holes are braſs dolphins *(H)* fixed on turning joints, and having cymbals *(I)* hanging by chains from their mouths below the holes of the buckets.

Within the arca which contains the water is a kind of inverted funnel *(K)*,[2*] under which wedges *(L)*, of about three digits high, are laid, to level the ſpace between the under lip of the pnigeus *(K)* and the bottom of the arca. Upon the neck of this (pnigeus) is fixed the little ciſtern *(M)* which ſupports the head of the machine, called by the Greeks *canon muſicos*.

(1*) This deſcription of the hydraulic organs has been thought to be unintelligible: ſome of the tranſlators have ſhewn their ideas of their conſtruction; but they are very far from being juſt, as will appear by comparing the figure given by Barbaro and Perrault with the ſketch here repreſented. I have obtained ſome elucidation of the ſubject from the works of ſundry antient authors; particularly from Heron's Treatiſe of Pneumatics, which has enabled me to underſtand Vitruvius ſo far as to give a ſlight repreſentation of the general conſtruction of theſe antient muſical machines. I have been obliged in many caſes to retain the original names of the members, there being no terms in our language ſuitable.

(2*) This paſſage — *ineſt in id genus uti infundibulum inverſum*—is corrected by Turnebus to—*ineſt pnigeus uti infundibulum inverſum*; and alſo *phigeos*, a little below, he changes to *pnigeos*. Theſe corrections appear to be juſt; for Heron ſays the inverted funnel, or hemiſphere (as he calls it), was named *pnigeos*.

In the length of this (canon) are channels (*N*), in number four if tetrachordic, ſix if hexachordic, and eight if octachordic. In the ſeveral channels are epiſtomia (ſtoppers) *(P)*, having iron handles (*Q*); which handles, when turned, open orifices (*O*) from the arca (arcula)[3*] into the channels. The canon has alſo holes (*R*) ranged tranſverſely, communicating with the channels, and correſponding to orifices (*S*) in the upper table, which in Greek is called *pinax*. Between the table and canon are diſpoſed rulers (*T*), which being perforated in the ſame manner, and anointed with oil that they may be eaſily moved to and fro, ſtop theſe holes, and are called *pleuritides*[4*]; the paſſing and repaſſing of which alternately ſtops and opens the holes.

Theſe rulers have iron *choragia*[5*] (*U*) affixed to them, and are united to pinnæ (*WVX*), the touching of which pinnæ cauſes the motion of the rulers. Upon the table are the holes (*S*), through which the air from the channels paſſes. To the rulers are fixed rings, in which the tongues of all the organic pipes (*Y*) are incloſed. From the buckets (*D*) proceed tubes (*Z*), united to the neck of the pnigeus,[6*] and communicating with the orifices that are in the arcula; in theſe tubes are fixed well-turned valves (*a*), which, when the arcula has received the air, ſtop their apertures, and prevent its return.

Thus, when the handles of the levers (*G*) are raiſed, the piſtons of the buckets are drawn to the bottom; and the dolphins that are fixed on axes lowering the cymbals that hang from

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(3*) I am of opinion that *arcula* ſhould be here read inſtead of *arca*; for it is with the former that the channels immediately communicate, as has been juſt expreſſed.

(4*) This word is written *plinthides* in all the manuſcripts that I have ſeen; although all the printed editions have *pleuritides*, as here written.

(5*) Vitruvius explains not what he means by *choragia*, which in Greek ſignifies *dancers*. The commentators ſuppoſe ſome kind of ſprings are intended by that word: and this ſuppoſition ſeems to be well founded; for, by the deſcription of Heron, it appears that a curved flat piece of horn *U* (Vitruvius ſays, iron) was fixed before each ruler, and a ſtring (of gut) *V* tied from the end of this horn ſpring to the rulers *T*; which latter, when driven backward by the preſſure of the hand on the pinnæ *X*, was by this means drawn forward again as ſoon as that preſſure was removed.

Heron alſo gives us the deſcription of the pinnæ, which Vitruvius has omitted. They were in the form of a right angle *VWX*; the perpendicular leg *VW* was joined at its lower end *V* to the ruler, with a moveable joint, and it alſo turned on an axis at its angle *W*: when therefore the end *X* was preſſed down, it cauſed the ruler to move backward; ſo that the holes *TT* in the ruler, coincided with the holes *R* and *S* in the canon and upper table, and by that means admitted the air from the channels to paſs into the pipes *YY*, thus cauſing them to ſound. But when the preſſure at the end *X* was removed, the horn ſpring *U* drew the ruler back again to its former place; and thus, the holes *T* in the ruler, no longer coinciding with thoſe of *R* and *S*, the mouths of the pipes were thereby ſtopped; ſo that by preſſing down the pinnæ (or keys, as we call them), in the ſame manner as in our modern organs, the pipes were cauſed to ſound.

(6*) Turnebus here alſo alters *ligneis cervicibus*, collars of wood, to *pnigei cervicis*, the collar of the pnigeus; and *lignea*, a little farther on, to *pnigea*. The correction is generally received by the tranſlators; and appears to be right, for the reaſons before mentioned.

their mouths, the cavities of the buckets become filled (with air). Then the piſtons being raiſed into the buckets again, with frequent and ſtrong pulſations, and thereby cauſing the cymbals to ſtop the upper holes, the air, which is there confined, is by the preſſure forced into the tubes (*Z*), from whence it paſſes into the pnigeus, and through its neck into the arca[7*] (arcula); and the frequent motion of the levers ſtill violently compreſſing the air, it ruſhes through the apertures (*O*) of the epiſtomia, and fills the channels with wind: when therefore the pinnæ are touched by the hand, they thruſt forward and draw back the rulers, alternately ſtopping and opening the holes; and thus, by the art of muſic, ſounds in an infinite variety of modulations may be produced.

I have thus endeavoured to explain, as well as I could by writing, this complex machine; but the conſtruction thereof cannot be eaſily underſtood, except by thoſe who are practiſed in things of this ſort: thoſe, however, who underſtand a little from the deſcription, will, when they ſee the machine itſelf, more eaſily comprehend it, and will find the whole curiouſly and ingeniouſly contrived.

CHAPTER XIV.

Of the Manner of Meaſuring the Way when travelling.

WE now transfer our attention to a contrivance left us by the antients, that is very ingenious, and not unuſeful; by which, while ſitting in a chariot on the road, or ſailing on the ſea, we may know how many miles we paſs; it is done thus:

Fig. LXXXIX. and Fig. XC. The wheels (*A*) of the chariot are to be in diameter four feet and a ſixth[1*]; ſo that, a point being marked on the wheel itſelf, from whence it may begin its

(7*) *Arculam* ſhould be here read inſtead of *arcam*, for the reaſon mentioned at note 3.

(1*) *Pedum quaternum & ſextantis*, four feet and a ſixth. Perrault and Galiani have altered this paſſage to *pedum quaternum*, four feet, for the following reaſons:

Vitruvius hereafter ſays, that in four hundred revolutions this wheel paſſes over a ſpace of five thouſand feet, or a Roman mile: the circumference therefore of the wheel muſt be twelve feet and a half; and, if ſo, the diameter can be but four feet, or thereabout; which is a fact. They alſo alter *pedum XII.* twelve feet, a little below, as

revolution on the ground of the road, when it arrives again at that point from whence it began to revolve, it will have paſſed the exact ſpace of XII. S. feet. This being prepared, then on the nave of the wheel, at the inner ſide, a tympanum (*B*) is ſecurely faſtened, having one little tooth (*B*) projecting beyond the line of its circumference. At the ſeat of the chariot above, a little box is firmly fixed, having incloſed a moveable tympanum (*C*), diſpoſed perpendicularly, and ſet on an axis. On the edge of this tympanum are made teeth, equally arranged, being in number four hundred, and fitting the tooth of the lower tympanum (*B*): alſo on the flank of the upper tympanum (*C*) is fixed a tooth (*C*), projecting farther than the other teeth. Then above this is a third tympanum (*D*), diſpoſed horizontally, toothed in the ſame manner, and incloſed in another box: the teeth of this (latter) correſpond to that tooth which is fixed on the flank of the ſecond tympanum (*C*). In this tympanum (*D*) are made holes (*e*), ſo many as are equal to the number of miles the chariot may go in one day; whether more or leſs is of no importance. In all theſe holes round ſtones are laid; and, in the theca or box of this tympanum, one hole has a little channel (*F*), through which the ſtones that are put in the tympanum, when they arrive at that place, may fall into the ſeat of the chariot, and into a braſs vaſe (*G*) there diſpoſed. Now, as the wheel revolves, it turns with it the lower tympanum (*B*); whoſe tooth, in each revolution, impelling the teeth of the upper tympanum (*C*), cauſes them to move round; ſo that, when the lower tympanum (*B*) has revolved four hundred times, the upper one (*C*) will have turned but once, and the tooth that is fixed on its flank will have moved but one tooth of the horizontal tympanum (*D*): when therefore the lower tympanum has completed four hundred revolutions, and the upper has turned once, the diſtance travelled will be five thouſand feet, that is, a thouſand paces (one mile). Now the ſtones, by cauſing a ſou ndwhen they fall, give notice of every mile that is paſſed; and the whole number of ſtones being collected from the bottom, ſhews the number of miles travelled in the day.

Fig. XC. In ſailing, likewiſe, a few parts being altered, the ſame contrivance will anſwer. For an axis (*H*) being put through the ſides of the veſſels, with the ends projecting

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it is written in the printed editions of the text, to *pedum XII. S.* twelve feet and a half, for the ſame reaſons. Upon examining ſeveral manuſcripts, I find they all agree with the printed editions, in having at the former paſſage *pedum quaternum & ſextantis*; but all differ from the printed copies at the latter paſſage, in having *pedum XII. S.* not *pedum XII.* I conjecture therefore that the former paſſage, although not really right, is perhaps right according to Vitruvius's intention, who might probably reckon the circumference of the circle to be but three times the diameter, as in a curſory manner it may have been ſometimes computed (as it now is by our workmen), although not the accurate proportion of thoſe parts of the circle. This conjecture is the more probable, as the ſame words, *pedum quaternum & ſextantis*, are again repeated further on in this chapter; which is a confirmation of its being the idea of Vitruvius, although not ſtrictly juſt: his own ideas, however, although erroneous, ought to be given by his tranſlators; at the ſame time that they may be accompanied with a notice of the error.

outward, on theſe (ends) are fixed wheels *(I)* four feet and a ſixth in diameter, having pinnæ (*K*) affixed round their edges, and touching the water. The middle of the axis, in the middle of the veſſel, has alſo a tympanum with one tooth (*B*) ſtanding beyond its circumference: at this place is a box incloſing another tympanum (*C*), with four hundred teeth divided thereon, agreeing with the tooth of the tympanum (*B*) that is fixed on the axis (*H*); it has alſo on the ſide another tooth (*C*) affixed, projecting from its circle. Above, in another box, is incloſed a horizontal tympanum (*D*), toothed in the ſame manner[2*]; by which means the tooth (*C*) that is on the ſide of the tympanum (*C*), that is placed edgeways, entering in the teeth of the horizontal tympanum, and in ſeveral revolutions moving the ſeveral teeth of the circle, cauſes the horizontal tympanum to revolve. In this horizontal tympanum are holes (*e*), in which holes the round ſtones are laid; and in the theca or box of this tympanum one hole is bored, having a channel (*F*), through which the ſtone, when freed from the obſtruction, falls into a braſs veſſel (*G*), and cauſes a ſound.

Thus, when the ſhip is propelled forward, either by oars or the wind, the pinnæ that are on the wheels touching the oppoſing ſtream of the water, that has a retrograde impulſe, turn the wheels; theſe turn the axis to which they are joined; and the axis turns the tympanum (*B*), whoſe tooth, in the ſeveral revolutions, impelling the ſeveral teeth of the ſecond tympanum (*C*), cauſes its regular rotations: ſo that the wheels, when they have been turned by means of the pinnæ four hundred times, move the horizontal tympanum once,[3*] by the im-

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(2*) Theſe words, *toothed in the ſame manner*, are not, I believe, to be underſtood to ſignify that this horizontal tympanum is to have an equal number of teeth, but only that the teeth are to be formed ſimilarly; the number of teeth being at pleaſure, as in the horizontal tympanum of the chariot before deſcribed: for ſuch a number ſeems unneceſſary in the horizontal tympanum, being many more than the number of miles the veſſel can go in a day; and would, beſides, require it to be inconveniently large.

(3*) "Ita, cum quatercenties ab pinnis rotæ fuerint "verſatæ, ſemel tympanum planum circumagent im-"pulſu dentis qui adlatus eſt fixus tympani in cultro."—Perrault remarks that there is a miſtake in this paſſage; and ſo there would be, if the word *circumagent* ſignified the turning an entire revolution, as he has underſtood it; for it muſt be the perpendicular tympan (having 400 teeth) that turns an entire revolution, while the water wheels (or thoſe with the pinnæ) revolve four hundred times; and that perpendicular tympan having but one tooth in its circumference that touches the teeth of the horizontal tympan, this latter can turn only ſo far round as that ſingle tooth (of the perpendicular tympan) can turn it, while the water wheels revolve four hundred times.

Perrault would alter the reading to *tympanum in cultro*, the perpendicular tympanum—inſtead of *tympanum planum*, the horizontal tympanum. But if the word *circumagent* may be allowed to ſignify the turning a portion of a revolution only (as Galiani, as well as myſelf, thinks it may) then the text, as it ſtands, is perfectly right: and this indeed muſt be the meaning of the word in Vitruvius's idea; for he ſays it is *turned once by the* (ſingle) TOOTH *of the perpendicular tympanum*. But he muſt have known that it is impoſſible for a wheel to be turned an entire revolution by a ſingle tooth of another wheel, howſoever conſtructed or connected with it, and therefore he could not intend to expreſs ſuch an idea: he muſt mean that it was moved ſo far round as that ſingle tooth could turn it, which muſt be equal to the diſtance of the holes wherein the ſtones were laid; ſo that one ſtone might fall at each movement of the wheel.

pulſe of the tooth that is on the ſide of the perpendicular tympanum. Hence, as often as by the rotation of the horizontal tympanum the ſtones are brought to the hole, they are diſcharged through the channel; and thus by their ſound, and their number, indicate the number of miles navigated. I think I have now ſufficiently deſcribed the conſtruction of thoſe things that are prepared both for uſe and pleaſure in times of peace and ſecurity.

CHAPTER XV.

Of the Catapultæ and Scorpions.

I SHALL now treat of thoſe machines that have been invented for the purpoſe of defence, and preſervation from danger; namely, the Scorpions, Catapultæ, and Baliſtæ; with the rules and proportions by which they may be conſtructed: and firſt of the Catapultæ and Scorpions.[1*]

(1*) This part of the writings of Vitruvius has engaged the attention, and employed the abilities, of many able men, for ſeveral centuries paſt. The conſtruction of the antient military engines, of which this and ſome following chapters treat, has been long unknown; and the diſcovery of this curious part of antiquity has been conſidered as a reſearch worthy the endeavours of the learned and ingenious. When gunpowder, and thoſe immenſely powerful modern engines, cannons, became generally uſed, another mode of warfare neceſſarily commenced; the engines of the antients were gradually diſuſed, and were ſoon ſo entirely neglected that their formation was forgotten: and for ſeveral centuries paſt no example or remains, ſufficient to elucidate their conſtruction, have been known to exiſt; nor have the treatiſes written to explain them, by ſeveral antient authors, been hitherto underſtood. Valturius, Lipſius, Baldus, Buteus, and other modern authors, have publiſhed their reſearches on this ſubject; and almoſt all the tranſlators and commentators of Vitruvius have laboured thereon without ſucceſs. To obtain a knowledge of theſe engines, from the writings of Vitruvius alone, could not be expected; for his account of them cannot be called a deſcription. He mentions neither the form, uſe, or place of their ſeveral parts, but their names and proportions only; pre-ſuppoſing that their forms and parts were ſufficiently known, as they undoubtedly were in his time. But many of the names and terms that he uſes are now unintelligible, and the proportions are expreſſed in characters of whoſe ſignification we are doubtful: many of thoſe characters are corrupted and miſwritten by the copyiſts; differing in different manuſcripts, and diſagreeing with the account of other antient authors who have written on the ſame ſubject; ſo that there is no being certain on which we may or may not rely.

Daniel Barbaro, in his Italian tranſlation of Vitruvius, publiſhed ſo long ſince as the year 1556, commenting upon this part of Vitruvius's work, ſays, "It is here neceſſary that God aſſiſt us; for neither the writings of Vitruvius, nor any delineation, nor any antient remains of theſe engines, will afford us any aid." He adds, "I hope therefore I ſhall be excuſed for not attempting to explain things that by their difficulty, and almoſt impoſſibility, have defeated the attempts of men of much greater

Fig. XCV. All their proportions are determined by the length of the arrow that the machine is intended to diſcharge; of which a ninth part is to be the magnitude of thoſe

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experience and ingenuity." Jocundus has given a figure of a baliſta that he copied from Atheneus; but acknowledges that he neither underſtands it, or the deſcription of Vitruvius which he tranſlates. Perrault alſo obſerves that the account "given by Vitruvius of theſe engines has not been underſtood by any perſon, although a great number have aſſiduouſly applied themſelves thereto: that the deſcriptions given by Atheneus, Vegetius, Marcellinus, and other antient authors, are of no avail; neither will the repreſentations on the Trajan column, thoſe in the book intitled Notitia Imperii, that which Du Choul copied from an antient marble, nor the model ſeen by Lipſius in the armory of Bruſſels, afford any illuſtration of the diſcourſe of Vitruvius: and that it is no wonder that machines, difficult to be explained by writing, eſpecially without delineations, ſhould not be underſtood from a deſcription that was at firſt neglected by the author;" and, he might have added, afterward corrupted and mutilated by thoſe who have copied it.

Perrault however proceeds to comment upon divers parts of the diſcourſe, and has attempted to give a repreſentation of a Catapulta. But it ſo little accords with, and in ſome parts is ſo contradictory to, the words of Vitruvius, that it can only be conſidered as a work of imagination: and his comments and concluſions may remain as inſtances how far a diſcourſe may be ſtrained to ſupport the moſt foreign idea; and how far we may be miſled by our imaginations, when unguided and undirected by ſome certain clue. This will more evidently appear to the reader upon comparing Perrault's comments with what is hereafter advanced.

Galiani, in his tranſlation of Vitruvius, only recapitulates the difficulties attending the diſcovery, and gives up the attempt: alleging that he does not believe the diſcovery to be now among the poſſibilities; and that he ſhall therefore content himſelf with giving the tranſlation according to the letter of the text, as others have before done.

Like the preceding tranſlators, I have alſo endeavoured to diſcover the formation of theſe antient machines, in order to make this part of Vitruvius's work more intelligible; but whether with better ſucceſs, the public judgment will beſt determine. I have diligently ſought for, and attentively peruſed, the authors who have written on the ſubject, and believe I have obtained ſuch a knowledge of it as will enable me to give the reader an idea of theſe curious antient engines; the deſcription of which here precedes the diſcourſe of Vitruvius, that his account, being afterward read, may be the better underſtood.

The military engines of the antients were diſtinguiſhed into the *euthytonæ* and the *palintonæ*; the former were thoſe that diſcharged arrows, darts, &c. and the latter thoſe that diſcharged ſtones, or both ſtones and arrows: of the former kind were the Scorpion and the Catapulta; of the latter, was the Baliſta. Theſe names were generally thus applied in the time of Vitruvius, although in after times they were often confounded one with the other.

The Scorpion was the ſmalleſt and leaſt powerful; it was ſo called from being in form a little like the inſect of that name. It conſiſted of a bow *A A*, *Fig. XCI.* made either of ſteel, or of ſome elaſtic wood, having a cord of ſinews ſtrained from one end to the other, and faſtened in holes made at the ends for that purpoſe. To its middle was joined the regula *B B*, having in its upper ſurface a channel *C*, of a dovetail ſhape, the lower part being the wideſt. This regula was called the *ſyrinx*; it was made of hard wood, and was fixed upon a board *D E*, a little longer and broader than itſelf, called the *catagogis*. Upon the ſyrinx was diſpoſed another regula, *Fig. XCII.* equal in breadth, and nearly in length, to the ſyrinx, and having a dovetail maſculus *F*, fitting the ſhape and ſize of the dovetail channel in the ſyrinx. This latter regula was called the *dioſtra*; and being placed in the ſyrinx, with its maſculus inſerted in the dovetail channel *C*, it might be ſlid to and fro thereon, without danger of ſeparating. In the upper ſurface of this dioſtra was made a ſemicircular channel *G*, the whole length, called *epitoxis*, wherein the arrow was laid; and near the end thereof, fartheſt from the bow, were two upright iron cheeks *HH*, *Fig. XCIII.* called *catochas*, and which were fixed upon the dioſtra a little diſtance aſunder: between theſe was placed an iron grapple or hand *I*, called *chira* and *manucla*: one end of this was bent backward like a hook, and cloven ſo as to admit the thickneſs of the arrow between; the other end was pointed. Through the ſides of the catochas and chira was put an iron axis *K*, ſo that the chira had a vertical rotation thereon. Under the pointed end of the chira lay the end of a thin iron bar *L M*, which was fixed to the upper ſurface of the dioſtra, on the left hand of the epitoxis, by an iron pin, on which it turned horizontally. This bar was called the *ſchaſteria*: and while its end *L*

holes (*I L K M*) in the capitules, through which are diſtended the twiſted cords of ſinews that retain the arms of the catapultæ; and by theſe holes the height and breadth of the capitule is thus determined.

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remained under the end of the chira, it prevented the latter from turning on its axis; but when removed, by drawing forward its end *M*, admitted the hooked end *I* of the chira to turn over to the place of the pointed end *L*, which end conſequently turned under to the place of the hooked end, a chaſe being cut in the dioſtra to admit its paſſing. The ends of the bow were ſo curved upward, that the bow-ſtring might freely paſs over the upper ſurface of the dioſtra, although the middle part of the bow was lower than the maſculus at the under part of the dioſtra. The catagogis was rounded at the end *E* next the bow, and was hollowed at the other end *D*; in which hollow, *D*, the archer applied his belly. He then puſhed the dioſtra forward, till the chira *I*, *Fig. XCIV.* arrived at the bow-ſtring, which latter he put over the hooked end of the chira; the ſchaſteria being previouſly put under the pointed end of the chira, to prevent its turning round and letting go the bow-ſtring. He then with all his power puſhed the farther end *F* of the dioſtra againſt ſome wall, or againſt the ground, keeping his body in the hollow *D* of the catagogis, and by theſe means forced the dioſtra and chira toward him; and, the chira having hold of the bow-ſtring, this latter was alſo drawn toward him, and the bow thereby bent.

To prevent the dioſtra being drawn back again by the bow, the following contrivance was uſed: An indented ruler *N* was fixed to each ſide of the ſyrinx, along its whole length; and an iron catch *O*, called *cataclida*, turned on an axis vertically on each ſide of the dioſtra: as therefore the dioſtra moved onward, the cataclidæ fell ſucceſſively between the ſeveral teeth of the ruler, and thus prevented the dioſtra from being drawn back again by the bow.

When the bow was bent as much as was judged ſufficient, and held ſo by the cataclidæ, the archer laid the arrow in the epitoxis, inſerting the feathered end between the cloven parts of the chira quite home to the bow-ſtring, which entered a notch made in that end of the arrow for that purpoſe. He then raiſed the whole machine, took his aim by looking along the arrow; and then, taking hold of the outer end *M* of the ſchaſteria, drew it toward him, and of conſequence drew the other end of the ſchaſteria from under the chira; which by the pull of the bow-ſtring inſtantly turned on its axis, and thereby let free the bow-ſtring, and diſcharged the arrow with great force.

This machine, on account of its effect being produced by the application of the belly, was called *gaſtrapheten*.

The Catapulta was an engine for the ſame uſe, but of greater power. To increaſe the power in a great degree, without greatly increaſing the ſize, and thereby rendering the machine too unwieldy and unmanageable, required ſome difference in the conſtruction; and chiefly in the part that was the cauſe of its power, *viz.* the bow. But if the power of the bow or arms were increaſed, it became neceſſary alſo to increaſe the power that acted on thoſe arms. This, inſtead of being done by the additional ſtrength of men, was more conveniently and effectually done by the application of ſome mechanical power; and this occaſioned another difference in the machine. Theſe differences therefore were as follows: Inſtead of a bow, as in the ſcorpion, the catapulta had a rectangular frame of wood *A B C D*, *Fig. XCV.* conſiſting of four upright pieces placed at proper diſtances; and two horizontal pieces, one *AC* over, and the other *B D* under, the ſaid four upright pieces, and to which they were ſtrongly connected by tenons and iron plates. The horizontal pieces were called *ſcutulæ* and *tabulæ* by the Romans, and *peritretæ* by the Greeks. The two outer upright pieces, *A B* and *C D*, were called *paraſtæ*; and the two inner ones, *E F* and *G H*, *meſoſtæ*. The whole frame is called by Vitruvius the *capitule*, and by Heron the *plinth*. Holes *I K L M* were bored perpendicularly through both the peritretæ, in the middle between the paraſta and meſoſta, both on the right and left ſide of the capitule. Acroſs the holes of the upper peritreta were laid two ſtrong iron bars *I L*; and two more *K M* were applied to the holes, in the ſame manner, under the lower peritreta: theſe iron bars were called *epizyges*. Then to the upper epizygis *I* one end of a cord of gut or ſinews was tied; and the other end carried through the holes of both the peritretæ to the lower epizygis *K*, ſtrained round it, and carried again through the ſame holes to the upper epizygis *I*, around which it was ſtrained, and carried again in the ſame manner to the lower epizygis: and thus repeated till the holes were quite filled, and would admit no more of the cord to paſs. In the middle *N* of this complication of cords, one end *N* of an arm of ſteel or elaſtic wood was inſerted, the other end *O* projecting beyond the face of the adjacent

The tabulæ (*AC* and *BD*) that are at the top and bottom of the capitule, and are called

paraſtæ *AB*; and then the two epizyges *IK* were turned about, ſo as to twiſt the cords with great violence: by this means the arm *NO* was held faſt, and cauſed to preſs backward with great force againſt the face of the paraſta *AB*, where it entered a ſemicircular excavation *R*, made there to receive it. The ſame operation was repeated on the other ſide of the capitule with the epizygis *L* and *M*, and the arm *P Q*; and the two arms thus held by the twiſted cords of ſinews acquired a great degree of elaſtic power, and anſwered the purpoſe of the bow in the before-deſcribed ſcorpion.

Through holes made at the ends *O* and *Q* of the arms was put the bow-ſtring *O Q*, which was a cord of ſinews of the ſtrongeſt texture; and was of ſuch a length as to ſuſtain the arms at a little diſtance from the paraſtæ, that in their recoiling they might not ſtrike againſt thoſe members, and be thereby damaged: or a cuſhion was ſometimes placed there for that purpoſe. The arms were called *brachia* and *ancones*; the complication or column *IK* of twiſted cords that held the arms was called *hemitonus*, and ſometimes *unitonus*. The interval *FH* between the two hemitones was left for the ſyrinx and dioſtra, formed as in the ſcorpions; the end of the ſyrinx being firmly fixed upon the upper ſurface *S* of the lower ſcutula or peritreta.

Heron deſcribes another capitule, with ſome but with no material difference: the ſcutula or peritreta being made in ſhape like a ſemi-octagon *ABCDEF*, *Fig. XCVI.* ſo that it was broader in the middle than at the ends; and the two meſoſtæ *GE* and *HD* were conſequently broader than the two paraſtæ *AF* and *BG*; the breadth of each being determined by the interſection of the inner ſides *I* and *K* of the paraſtæ, and the outer ſides *E* and *D* of the meſoſtæ, with the ſemicircle *AIEDKB*, as ſhewn by the figure.

Fig. XCVII.

To the capitule *AA*, thus formed, was fixed, as before ſaid, one end of the ſyrinx *B*, being, with the dioſtra *CH*, chira and ſchaſteria *D*, and cataclida *O*, made in all reſpects the ſame as before deſcribed in the ſcorpion, but without the catagogis; inſtead of which a ſucula or windlaſs *E* was connected to the other end of the ſyrinx, whoſe ſides *F* projected forward in order to receive it. To the middle part *G* of this ſucula, between the two ſides of the ſyrinx, was fixed a cord *G C*, extending from thence to the end *C* of the dioſtra, where it was faſtened to a hook; when therefore the machine was prepared as deſcribed in the ſcorpion (that is to ſay, the dioſtra puſhed forward till the chira arrived at the bow-ſtring *IKI*, and hooked it), the dioſtra was drawn back again by means of the ſucula, which was turned round by two men, with the aſſiſtance of levers *L* put through each end of the ſame; and thus the arms *I* were drawn and ſtrained: this being done ſufficiently, the arrow *KH* was then laid in the epitoxis, and diſcharged in the manner before deſcribed.

The larger engines of this kind, in which the power was very great, were drawn by pulleys in various combinations, or with pulleys and ſuculæ connected together: and inſtead of the ſimple iron axons, or epizyges, that ſuſtained the tonus of cords, the machines *M*, called by Vitruvius *modiols*, and by Heron *choenices*, were uſed; and which will be explained in the deſcription of the Baliſtæ.

This engine being too large and heavy to be managed in the hand, and being required to be turned and elevated in different directions, it became neceſſary to ſupport it on a baſe that ſhould afford the required conveniences. This baſe was thus conſtructed:

A poſt *N* (or *columella*, as Vitruvius calls it), about two feet and a quarter high, was fixed upright upon a three-legged baſe *P Q R*, and ſupported by three braces *SSS* on the ſame. At the top of the columella was a cylindric tenon *T*, on which turned the chalcheſium *U, a, V*, which was formed thus:—On a horizontal rectangular board *U V* two perpendicular rectangular ſides *Ua*, and *Vb*, were fixed to the right and left; and between theſe was another horizontal board *bcd*, a little above the former.

Through the middle of the two horizontal boards holes capable of receiving the tenon *T* of the columella were bored. The two perpendicular ſides were ſo far apart as to admit between them the breadth of the ſyrinx; which being introduced, an iron axis *e* paſſed horizontally through the ſides of the chalcheſium and thoſe of the ſyrinx, connecting them together, and admitting the ſyrinx to turn vertically on the ſaid axis: ſo that the whole catapulta could be elevated and declined to any direction: and, by the chalcheſium turning on the tenon of the columella, it could alſo be turned horizontally to any direction required, and by theſe means be pointed againſt any intended object.

To keep it ſteadily fixed when thus directed, one end *f* of a piece of timber *fg* was annexed to the top of the columella, by a joint that admitted it to turn horizontally; ſo that the other end *g*, reſting on the ground, might be placed in different ſituations. This piece was called *anteridium*; near to the upper end of which the *anapauſteria*, *h i*, was annexed, with a joint admitting it to be elevated and declined. When therefore the ſyrinx was ſet to its re-

parallels, are made one hole in thickneſs, in breadth one and three quarters,[2*] and at the extremities one hole and S.[3*] The paraſtæ (*AB* and *CD*) on the right and left, without the tenons (cardines), are made four holes high, and five holes thick; the tenons (*AB*) S. Q. of a hole. From the hole to the middle paraſta (*EF*) it is alſo S. Q. of a hole.

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quired direction, the lower end *g* of the anteridium was moved, and fixed to the ground, ſo that the anapauſteria might remain perpendicularly under the ſyrinx: and then the end *i* of the anapauſteria was raiſed, and fixed to the bottom of the ſyrinx, in holes there made; by which means the ſyrinx was kept firm in its poſition till the arrow was diſcharged.

The catapultæ were made of different magnitudes: but there were two ſizes moſt generally uſed, of which the ſmaller were called *triſpithamal*, becauſe they threw arrows of three ſpans long; and the larger were called *tricubital*, becauſe they threw arrows of three cubits, or ſix ſpans, long.

The proportions of their ſeveral parts are given by Vitruvius; but they are ſo corrupted as not to be truſted to. Heron ſays all the proportions muſt be determined by experience and trial. Philo mentions many of them, and therein differs greatly from Vitruvius. They all agree, however, that the proportions were regulated by the ſize of the holes in the ſcutula, and that the diameter of thoſe holes was always made equal to a ninth part of the length of the arrow that the catapulta was intended to diſcharge.

(2*) It is not always eaſy to diſcover the parts to which the terms of Vitruvius allude: thoſe that have appeared to me to be meant, I have referred to by letters. The term *tabula* here mentioned ſeems to me to allude to the horizontal pieces *AC* and *BD*, *Fig. XCV.* called *peritreta* by the Greeks.

Galiani has tranſlated this meaſure "one and one eighth," inſtead of one and three quarters; probably by miſtake.

(3*) It may be proper, before we proceed farther, to take ſome notice of the characters Vitruvius uſes in treating this ſubject, as they are differently underſtood by the different commentators. Their different opinions are ſhewn in the following table; and this mark * is added to thoſe which agree with my own.

Characters.	Their Significations according to				
	Philander.	Jocundus.	Meibonius.	Perrault.	Galiani.
S.	$\frac{1}{2}$*	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$*
Mark of a Sicilicus, or $\frac{1}{4}$ of an Ounce 9.	$\frac{1}{4}$*	—	$\frac{1}{4}$	$\frac{1}{16}$	$\frac{1}{4}$
$\overline{\Gamma}$	$\frac{1}{16}$	$\frac{1}{16}$	$\frac{3}{16}$*	$\frac{1}{4}$	$\frac{1}{16}$
K	—	—	$\frac{1}{16}$*	$\frac{1}{4}$	$\frac{1}{16}$
Z	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{4}$*	$\frac{1}{8}$	$\frac{1}{6}$
ξ or $\overline{3}$	—	—	$\frac{1}{24}$	$\frac{1}{12}$	$\frac{1}{12}$
:—	—	—	$\frac{1}{4}$*	$\frac{1}{8}$	$\frac{1}{4}$
F	$\frac{1}{12}$	$\frac{1}{12}$	$\frac{6}{16}$*	$\frac{1}{12}$	$\frac{1}{6}$
A Duella, or $\frac{1}{3}$ of an Ounce $\overline{U}$	$\frac{1}{3}$*	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{4}$	$\frac{1}{3}$
. .	—	—	$\frac{1}{16}$*	—	—
⁘ ⁘	For periods in the Diſcourſe.				

The breadth of the middle paraſtæ (*EF* and *HG*) is one hole and IK, the thickneſs one hole; the interval where the arrow is placed between the middle paraſtæ is the fourth part of a hole. The four angles that are on the ſides and fronts are ſecured with iron plates, or braſs bars and nails.

The length of the canalicule (*CC*, *Fig. XCI.*), which in Greek is called *ſtrix*,[4*] is XIX. holes. The regulæ (*BB*), which ſome call *bucculæ*, that are fixed on the right and left of the channel, are XIX. holes; the height and thickneſs one hole: alſo two regulæ (*FF. Fig. XCVII.*) are affixed, in which is inſerted the ſucula (*EE*), being three holes in length, and half a hole in breadth. The thickneſs of the buccula that is affixed, called *camillum*, or, according to ſome, *loculamentum*, being fixed with a dovetail tenon, is I. hole, the height S. of a hole. The ſucula is in length[5*] ⁘ holes ⁝. The thickneſs of the ſcutula is IX. holes. The epitoxis (*GG*) is in length S :—· holes; in thickneſs :—. Alſo the chelo (cheira), or manucla (*I*, *Fig. XCII.*), as it is called, is in length III. holes, in breadth and thickneſs S :—· The length of the *fundus*[6*] of the channel is XVI. holes, the thickneſs a hole ⁘, the breadth S :—·

The columella and baſe on the ground is VIII. holes; the breadth in the plinth in which the columella is fixed up, is S:—· The thickneſs F. Z. The length of the columella to the tenons is XII. holes ⁘; the breadth S:—· of a hole. The thickneſs Ū.9; its three capreals (braces) are in length IX. holes, in breadth half of a hole ⁝, in thickneſs Z. The length of the cardo (tenon) a hole ⁘. The length of the head of the columella I. S. K. the breadth of the *anteſixa* S. ⁘ 9. of a hole, the thickneſs I. The poſterior ſmaller column, which in Greek is called *antibaſis*, is VIII. holes; the breadth S. I. of a hole, the thickneſs F. Z. The *ſubjectio* is XII. holes, the breadth and thickneſs is the ſame as that of the ſmaller column. The *chelonium*, or *pulvinus*, as it is called, upon the ſmaller column, is II. S. ⁘; the height II. S. ⁝;

(4*) Some commentators allege *ſyrinx* ſhould be here written inſtead of *ſtrix*; the former being the Greek name of a pipe. Heron uſes the term *ſyrinx*, as appears by the foregoing deſcription of the catapulta. But it may be obſerved that the thing here ſpoken of, is a channel, not a pipe; and that Vitruvius, ch. iii. b. iv. has applied the term *ſtrix* to the channel of a column. I have therefore left the word as in the text.

(5*) The number ſpecifying the length of the *ſucula* is wanting in all the copies. Galiani taking it from Ceſariani, has added *VIII. S. eight and a half*, for its length; and Barbaro, with Perrault, *nine*. But the length of the ſucula has juſt before been ſaid to be three holes; from whence I imagine that *ſcutula* has been here originally written, eſpecially as the thickneſs of that part immediately follows.

(6*) *Canalis fundi* is rendered by the tranſlators *the bottom of the channel*, and *the channel of the bottom*: but as, at the 13th chap. preceding, the term *fundus* is ſeveral times uſed for the *ſtoppers* or *ſliders* that move in the buckets or modiols, it appears to me probable that the word *fundus* is uſed as a technical term in this place, and ſignifies ſomething of the ſame kind. The epitoxis is the part *GG*, *Fig. XCII.*; and the *chelo* or *manucla* ſeems to be that called *cheira* or *hand* by the Greeks. At the 18th chapter following, the cheeks on each ſide the cheira are called *chelonia*.

the breadth S. I. :—. The charchebi[7*] of the ſucula II. S. I. ⁘, the thickneſs S. II. ⁘, the breadth I. S. The length of the tranſverſe pieces with the tenons X. ⁘, the breadth I. S. ⁘, and the thickneſs ten. The length I. S. of the arms (brachia) (*O O, Fig. XCV.*) is VII. holes, the thickneſs at the root F. Z. of a hole, at the top Ū. Z. of a hole ; the curvatures eight holes.

In theſe proportions, either enlarging or diminiſhing occaſionally, they are prepared ; for, if the capitules (*A B F E, Fig. XCV.*) be made higher than the breadth, as are thoſe called *anatona*, the arms are ſhortened ; that, where the tonus is weakened by the height of the capitule, the ſhortneſs of the arms may aid the force of the ſtroke. If the capitule be leſs high, which is called *catatonum*, the arms, on account of the great power, are made a little longer, that they may be more eaſily drawn ; for as, in the caſe of a lever, if when it be four feet in length a given weight may be raiſed with it by five men,[8*] when eight feet long that weight may be raiſed with it by two—for the ſame reaſon the arms that are longer are eaſier, and thoſe that are ſhorter are more difficult to be drawn.

CHAPTER XVI.

Of the Baliſtæ.

I HAVE ſpoken of the rules by which the parts and proportions of the Catapultæ are determined ; but the principles of the Baliſtæ vary, and are different, although prepared to produce ſimilar effects. For ſome are worked with levers and windlaſſes (ſucula), ſome with ſheaves of pulleys (polyſpaſtons), others with capſtans (ergatæ), and ſome alſo with wheels (tympanums). No baliſta, however, is made without having regard to the weight of the ſtone that the machine is to throw ; their principles therefore are not eaſy to all, but to thoſe only who have a knowledge of arithmetical rules and the powers of numbers : for in

(7*) *Charchebi* is corrected by Philander and others to *carcheſii :* this latter word is mentioned at the 5th chapter foregoing, and at the 22d chapter following, but is not at either place explained. It probably relates to that member which in the foregoing deſcription is called *chalcheſium*.

(8*) As two men with a lever of eight feet are equal in power to four men with a lever of four feet, here is moſt probably a miſtake ; and inſtead of *quinque*, five, it ſhould have been written *quatuor*, four ; to which Galiani has altered the text.

their capitules are made holes, through which cords of hair (that of women chiefly), or of ſinews, are drawn, and whoſe magnitudes are adjuſted by the laws of gravity to the weight of the ſtone that the baliſta is intended to diſcharge; as thoſe of the catapultæ are to the length of the dart. However, that thoſe who are unacquainted with arithmetic or geometry may be prepared, and not be occupied by ſtudy, in the time of the dangers of war, I ſhall here reveal what I have acquired by my own experience, as well as what I have learnt from authors; and as the rules of theſe things are founded on the weights and meaſures of the Greeks, I ſhall tranſcribe them ſo that they may alſo agree with our weights.[1*]

(1*) The capitule *AIHB*, *Fig. XCVIII.* of the baliſta was formed ſimilarly to that of the catapulta, excepting that the two hemitones *AFHC* and *DIEB* were diſpoſed farther apart, leaving a wider interval *CE* between the two *meſoſtæ GG*, which in the baliſta were called *antiſtæ*. The purpoſe of this engine, which was to throw large ſtones, required ſo large an interval: Heron ſays it ſhould be a little leſs than double the length of the arms *RS*.

The ſcutulæ or peritretæ *AF* and *DI*, which in the catapulta extended in one piece over both hemitones, were in the baliſta ſeparate, and extended over one hemitone only. The lower peritretæ *HC* and *EB* were alſo disjoined in the ſame manner; ſo that the two hemitones were not connected by their peritretæ, but by two other pieces of timber *KL* and *MN*; one of which *KL* extended over the two upper peritretæ, and the other *MN* under the two lower peritretæ; being ſecured to the ſame by tenons. The paraſtæ *O* were made like thoſe of the catapulta, but had a curvilinear protuberance *P* at the back part, oppoſite the circular cavity *Q* in which the arm lay, in order to ſtrengthen it. The antiſtæ *G* had alſo a curved protuberance toward *R*, called *hypopterna*, on the ſide toward the root of the arm, againſt which the ſaid root *R*, called *ptena*, reſted. The grain of the wood in the paraſtæ and antiſtæ was perpendicular; and tenons from the top and bottom of both entered the peritretæ, to ſecure them thereto. All the angles and joints of the whole capitule were fortified with iron plates.

The peritreta in this engine was made of a rhomboidal figure, in order to permit the arms to diverge the more. Heron deſcribes it thus:—In a rectangular parallelogram *abcd*, *Fig. XCIX.* whoſe breadth is half its length, a diagonal line *ac* is drawn; parallel to which is drawn *be*; *da* is continued to *e*; then *aebc* ſhews the figure of the peritreta: the ends *ae* and *bc* being ſwelled in a curve, to ſtrengthen it. Again, drawing *ce*, the interſection *f* of that line, with the line *ab*, ſhews the middle of the peritreta, where the hole of the tonus is bored.

Philo gives another rule for determining the obliquity or rhomboidal figure of the peritreta:—He ſays, divide a ſemicircle into eleven parts, and from the fourth diviſion draw a line to the center; which line ſhews the obliquity required. Vitruvius differs from both: he ſays the oblique formation ſhould be a ſixth part of the length, and a fourth of the breadth.

The capitule of the baliſta being finiſhed, the other members, anſwering to the ſyrinx, dioſtra, &c. of the catapulta, were added, as follows: To the timber *MN*, *Fig. XCVIII.* under the lower peritreta, was connected an horizontal frame of timber work *ABC*, *Fig. C.*; it conſiſted of ſeveral pieces of timber *DDD*, diſpoſed at equal diſtances the whole length of the capitule, projecting forwards, and being connected at their projecting ends by a tranſverſe timber *AB*. This frame was called *menſa*, and by the Greeks *trapeza*; upon it was laid the covering of boards *EE* called *tabula*, whoſe upper ſurface was level with the bottom of the lower peritreta. Upon the tabula was placed the *climax*, or, as Vitruvius calls it, *climaciclos*, *FGG*, which was a horizontal frame of timber, ſimilar to a ladder, whence it took its name; being compoſed of two longitudinal pieces *GG* and *FK*, connected by ſeveral tranſverſal pieces *HH*, at proper diſtances. The breadth of the climax (according to Heron) was equal to the interval between the antiſtæ; and the length nineteen holes according to Philo, although but thirteen according to Vitruvius. This climax anſwered to the ſyrinx of the catapulta, and lay upon the tabula, ſo as to project over each ſide of the ſame. Upon the two parallel longitudinal pieces of the climax were laid two others, called *alæ*, *II* and *KK*, of equal length and breadth; between which, and over the tranſverſe pieces *HH* of the climax, was the dioſtra *LLL*, being equal in length to the climax. The climax was firmly faſtened on the menſa, and ſecured by the anterides or braces *MM*, extending from the ends of the alæ to the upper peritreta.

The Cheira, Schaſteria, &c. *OP* were fixed upon the

dioſtra in the ſame manner as in the catapulta: but here the hooked end *P* of the cheira was not forked or cloven, but made like a finger; and the cheira was raiſed ſo far above the dioſtra, that the bow-ſtring, when forced therefrom, might ſeize the ſtone *Q* to be diſcharged about the middle of its height, that it might act more powerfully and certainly thereon. With the ſame intention, the arms *R R* were diſpoſed ſo as to cauſe the bow-ſtring in its recoil to move at that height above the dioſtra: alſo the bow-ſtring *S S* was made broad like a belt, not round like that of the catapulta; and it had a loop *P* in the middle, which hooked over the finger of the cheira. Theſe engines were made of the ſtrongeſt and tougheſt wood; and as light as a proper degree of ſtrength would admit, that they might be the eaſier conveyed from place to place; for which purpoſe alſo all the parts of the large engines were made to take aſunder, excepting the hemitones, which always remained entire, on account of the difficulty and time required to prepare the tonus *T T*; the method of doing which is deſcribed at the eighteenth chapter following.

In the baliſtæ and larger catapultæ, inſtead of the ſimple iron arcons or epizyges before mentioned, the machines *Fig. CI.* and *CII.* were uſed. They are called *choenices* by Heron, and *modiols* by Vitruvius; and were made, when ſmall, of braſs; when large, of ſome hard wood. The part *a* was ſquare, and lay upon the peritreta *c c*, over the hole of the tonus. The part *b*, above it, was circular; in the middle of the circle a hole *d d* was bored quite through the choenicis, equal in diameter to the hole *c* of the tonus in the peritreta. Adjoining the under ſurface of the ſquare part were four tenons or teeth, called *autitormi*, *f f*, which entered a circular excavation ſunk in the ſurface of the peritreta, around the hole of the tonus, in order to keep the choenicis firm in its place; and in the ſaid excavation, under the teeth, was an iron plate, to prevent the teeth from penetrating into the wood. On the upper ſurface of the circular part of the choenicis, a groove *g* was cut diametrically acroſs; and in this groove the epizygis *h h* was laid. One of theſe choenices was applied to each hole of the peritreta, through which the tonus was drawn, the teeth entering the upper ſurface of the upper peritreta, and the lower ſurface of the lower peritreta; and then the cords *i i* that formed the tonus were put round the epizygis, as before deſcribed in the catapulta; which being done, thoſe cords were twiſted, by turning the choenicis round with an iron wrench, *Fig. CIII.* having a ſquare collar *a b c d*, fitting the ſquare part *a a* of the choenicis.

When the choenicis was made of wood, the grain was always to be diſpoſed perpendicularly; but the epizygis was always made of the ſtrongeſt iron, becauſe it ſuſtained the whole power of the tonus. The proportions of the parts of the baliſta are here mentioned by Vitruvius, to which the reader is referred, with the caution before given in the explanation of the catapulta: ſome information may be drawn therefrom; but experience and trial, as Heron obſerves, muſt ultimately determine.

The baliſta was mounted on a baſe, which is mentioned both by Vitruvius and Heron, but deſcribed by neither. This baſe could not be exactly like that of the catapulta, for the different form of this engine would not admit it. Vitruvius, however, mentions ſeveral of its members by the ſame terms he uſed in ſpeaking of the baſe of the catapulta.

The baliſta was not worked by a ſucula, or any other power adjoined to it, as the catapulta was, but by detached powers of various conſtructions, differing as the ſtrength of the engine or other circumſtances required; ſome being, as Vitruvius ſays, worked with ſuculæ and levers, others by ſheaves of pulleys, and ſome by combinations of wheels and tympanums, placed at convenient diſtances and ſituations, or ſuch as the adjacent ground and objects would admit.

CHAPTER XVII.

Of the Proportions of the Baliſtæ.

A BALISTA that is made to throw a ſtone of two pounds weight, ſhould have a hole in its capitule of V. digits ⁘ if for four pounds, VI. digits and VII. digits[1*] ⁘ ten pounds, VIII. digits ⁘ twenty pounds, X. digits ⁘ forty pounds, digits XII. S. K. ⁘ ſixty pounds, XIII. digits and the eighth part of a digit ⁘ eighty pounds, XV. digits ⁘ a hundred and twenty pounds, I. foot and S. and a digit and half ⁘ a hundred and ſixty pounds, II. feet and V. digits ⁘ two hundred pounds, II. feet and VI. digits ⁘ two hundred and ten pounds, II. feet and digits VII. ⁝ two hundred and fifty pounds, XI.[2*] S.

(1*) *Digitorum VI. et digitorum VII.* are the words of the text: but it is ſuppoſed that the words *ſi pondo ſex*, if ſix pounds, were originally written before *digitorum VII.* and been careleſsly omitted by the copyiſts; for in the old Italian editions of Ceſariani and Durantino thoſe words are inſerted.

Perrault, however, ſuppoſes the words of the text, as at preſent found, to be right; and that they import that the hole may be made of any ſize between VI. and VII. digits.

(2*) Here is evidently an error in the text; for a hole ſo large as eleven feet and a half could not be required for the weight of 250 pounds, if a hole of two feet and ſeven digits was ſufficient for a weight of 210 pounds. Perrault has tranſlated the characters *XI. S. eleven digits and a half*, adding alſo *two feet* without the authority of the text; and which he ſuppoſes to have been an omiſſion. In ſeveral manuſcripts I find the paſſage written thus: CCCLX.—I. S. without the word *pondo* between them, as in the printed copies; from whence it ſeems probable that in the printed copies the X. has been erroneouſly detached from the former number CCCL. and added to the latter, inſtead of the I. S. and that it was originally written CCL.—II. S.; ſignifying, CCLX. pounds requires a hole of two feet and a half; for in that caſe the diameter of the hole will be one digit larger than the preceding hole, by which it will conform to the rule obſerved in the ſizes of ſeveral of the holes foregoing, each of which increaſes by a digit.

Philo has alſo given the ſizes of the holes proportional to ſtones of divers weights: and Buteus has made a calculation of the ſame, upon the ſuppoſition that a ſtone of two pounds required a hole of five digits. Theſe authors, however, differ from each other, and from Vitruvius, as the following table will ſhew.

A table ſhewing the diameter of the hole in digits for ſtones of various weights, according to different authors.

Weight of Stone in Pounds or Minæ.	Vitruvius.	Buteo.	Philo.
2	5	5	—
4	6	$6\frac{7}{24}$	—
6	7	—	—
10	8	$8\frac{11}{100}$	11
15	—	—	$12\frac{3}{4}$
16	—	10	—
20	10	—	$14\frac{3}{4}$
30	—	—	$15\frac{1}{4}$
40	$12\frac{9}{16}$	—	—
50	—	—	$19\frac{3}{4}$
54	—	15	—
60	$13\frac{1}{8}$	—	21
80	15	—	—
120	$21\frac{1}{2}$	—	25
128	—	20	—
160	32	—	—
180	37	—	27
200	38	—	—
210	39	—	—
250	40	25	—

Heron gives the following rule for determining the ſizes of the holes for ſtones of all weights: The number of minæ the ſtone weighed, was multiplied by 100, and the cube root of that product extracted, to which root a tenth part thereof was added, which gave the diameter of

When therefore the magnitude of the hole is determined, the ſcutula, which in Greek is called *peritretas*, is deſcribed, of which the length is holes II. F. Z.; the breadth two and a ſixth part. The deſcribed line is divided in half, and when divided the forms of the extremities are contracted, ſo that the oblique formation may have a ſixth part of the length and of the breadth, at the return (verſura) a fourth part. In that part alſo is the curvature in which the points of the angles project, and the holes are turned, and the contractures of the breadth return inwardly a ſixth part: the hole is ſo much oblong as the epizygis is thick. When it is deſcribed, it is divided around ſo that the extremity may have a gentle curvature ⁘ the thickneſs of it is S. $\bar{\Gamma}$. of a hole. The modiols are made II. :— holes, the breadth I. S. 9. ⁝⁝ the thickneſs, excluſive of what is inſerted in the hole, is S. I. of a hole; at the extremity alſo the breadth is I. $\bar{\Gamma}$. of a hole. The length of the paraſtatæ V. S. $\bar{\Gamma}$. holes; the curvature a half part of a hole; the thickneſs, $\bar{U}$ of a hole, and LX. part. At the middle the breadth is enlarged as much as it is near the hole made in the deſcription, in breadth and thickneſs $\bar{\bar{V}}$. of a hole, the height IV. parts. The regula which is on the menſa, is in length VI. holes, in breadth and thickneſs half of a hole; the cardo II. Z. ⁝⁝. The thickneſs of the curvature of the regula Γ. 5. K. The breadth and thickneſs of the exterior regula are the ſame; the length ſo much as is given by the ſame return (verſura) of the formation, and the breadth of the paraſtæ and its curvature K. The ſuperior regulæ are equal to the inferior K. The tranſverſe pieces of the menſa $\bar{U}$. $\bar{U}$. K. of a hole. The length of the ſhaft of the climaciclus is XIII. holes ⁝ the thickneſs III. K.

The breadth of the middle interval is a fourth part of a hole ⁘ the thickneſs an eighth part $\bar{K}$. The ſuperior part of the climaciclos, which is next to the arms, and which is joined to the menſa, is in the whole length divided into five parts, of which two parts are given to

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the hole in digits: thus a ſtone weighing ten minæ, required the hole to be eleven digits in diameter; for 10 multiplied by 100 produces 1000, the cube root of which is 10; to which adding a tenth part, *viz.* 1, the amount is 11 digits for the diameter of the hole.

But we are not informed for what mina this rule is calculated. The Attic mina contained 100 drachmas, of which the Alexandrian contained 160, and the Roman *pondus* 96; ſo that much depends on the weight of the mina here to be underſtood, and which in following this rule it is highly neceſſary to know. Heron himſelf was of Alexandria; and this rule of his makes the holes much larger for the minæ he means, than Vitruvius allows for an equal number of Roman pounds: theſe reaſons therefore, together with Vitruvius's aſſertion—"that he "has tranſcribed his account from the Greek authors, "but in ſuch a manner as to make it conform to the "Roman weights and meaſures," render it probable that it is the Alexandrian mina on which Heron's rule is founded; and upon this ſuppoſition, allowing alſo for the difference between the Roman and Greek foot, the ſizes of the holes found by this rule will nearly agree with thoſe given by Vitruvius, as well as thoſe of Philo, who ſeems to agree with Heron in uſing the Alexandrian mina.

Another method was alſo uſed by the antients for finding the ſizes of the holes for ſtones of different weights, which was this: Having the ſize of the hole for a ſtone of any weight given, the ſize of the hole for a ſtone of any other weight was found by the method uſed for doubling the cube, i. e. by finding two mean proportionals. It is by this method Buteo has made his calculation.

that member that the Greeks call *chelon* ⁘. The breadth $\overline{\Gamma}$. the thickneſs 9. ⁘ the length is III. holes and a half K.; the projecture of the cheles S. of a hole; the plinthigonatos ⅗. of a hole and a ſicilicus; that which is at the axon, called the front tranſverſarius, is three holes ⁘ the breadth of the interior regula $\overline{\Gamma}$ of a hole; the thickneſs ⅗. K. The replum of the chelon, which is the cover of the dovetail, is included K. The breadth of the ſhaft of the climaciclus Z. 5.; the thickneſs XII. K. holes. The thickneſs of the ſquare which is at the climaciclus F. 5. of a hole, at the extremities K. The diameter of the round axis is equal to the cheles; that to the clavicula S. is leſs by a ſixteenth part K. The length of the anterides F. III. 9. holes; the breadth at bottom a hole $\overline{\Gamma}$. ⁘ at top the thickneſs is Z. K.

The length of the baſe, which is called *eſchara*, is holes ⁝⁝ the antibaſe is holes IV. ⁘ and both the thickneſs and breadth a hole ⁝⁝ it is fixed at the half of the height K. The breadth and thickneſs of the column is I. S.; but the height is not proportioned to the holes, being made ſo much as is proper for the purpoſe of the work. The length of the arm ⁝⁝ is holes VI. ⁘ the thickneſs at the root a hole, and at the extremity F.

I have explained what I have thought moſt uſeful concerning the ſymmetry of the baliſtæ and catapultæ; but I will not omit to deſcribe, as well as I can by writing, the manner of preparing them with the twiſted cords of ſinews and hair.

CHAPTER XVIII.

Of the Preparation of the Baliſtæ and Catapultæ.

Fig. CIV. BEAMS (*ABCD*) of a ſufficient length are provided, upon which are fixed chelons (*E*), wherein ſuculæ (*F*) are included. At the middle part of the beams excavations (*GHI*) are made, in which excavations the capitules (*KLMN*) of the catapultæ are inſerted, and faſtened in with wedges (*O*), in ſuch a manner that they may not be moved by the diſtenſion. Then the braſs modiols (*P*) are inſerted in the capitule; and in them the

little iron pins (*Q*), which the Greeks call *epiſchidas*,[1*] are diſpoſed: then the ends of the ropes (*R S*) are put through the holes (*S*) of the capitules, and thrown on the contrary ſide, where, being joined to the ſucula (*F*), they are wound around it by the levers (*T*), ſo that the diſtended ropes, when ſtruck by the hand, may on both parts yield an equal ſound; they are then confined at the holes with wedges, that they may not ſlip. On the other ſide likewiſe, being paſſed through in the ſame manner, they are, by the levers and ſuculas, diſtended till they ſound equally. Thus, by the ropes being confined by the wedges, the catapultæ are adjuſted according to the rules of the muſical tones.[2*]

(1*) This word has probably been miſcopied, and ſhould be read *epizygidas*; for it undoubtedly alludes to the *epizygis h h*, *Fig. CII.* which was laid on the modiols or choenices, and which is mentioned by that name in the foregoing chapter.

(2*) This chapter explains the method of forming the tonus or combination of twiſted cords, from whence the power of theſe engines was chiefly derived.

For this purpoſe was uſed the machine *F. CIV.* called by Heron *entonium*. Vitruvius does not fully deſcribe it. The two parallel beams *A B C D* were connected by the two tranſverſe timbers *U U V V*, forming a rectangular frame, capable of receiving the capitule; the extremities of theſe tranſverſals *U U V V* paſſed through the parallel beams *A B C D*, and had holes *X*, in which wedges *O* being driven, confined the capitule ſecurely between the beams. The ſaid capitule *K L M N* being then placed between the beams, with the two peritretæ toward the two ſuculæ *F F*, and the choenices or modiols *P* being fixed in the holes, as before deſcribed, one end *Q* of the cord was faſtened to one of the epizyges, and the other end *R* carried through both choenices to the fartheſt ſucula *F F*, to which it was fixed. The end of another cord *S* was alſo tied to the other epizygis, and in the ſame manner carried through both choenices to the other ſucula *F*, and there fixed. Then both the ſuculæ were turned around by the levers *T*, ſtraining both the cords *R* and *S*, till they were diminiſhed in their thickneſs a third part; and (as Vitruvius ſays) till both, upon being ſtruck, yielded tones in uniſon. Wedges were then driven into the choenices, ſo as to ſecure the parts of the cords that were between the two choenices from ſlipping, and to preſerve them in the ſame degree of tenſion. After this, the other parts of the cords were looſened from the ſuculæ; conveyed round the epizyges, through both the choenices, in the ſame manner as before, and faſtened to the oppoſite ſuculæ; by which they were diſtended till they were alſo in the ſame degree of tenſion as the former: and this was repeated till the holes of the choenices were quite filled with the cords, and would admit no more.

When the holes were ſo nearly full that it became difficult to put the cord through them, an iron pin called *ceſtra*, *Fig. CV.* poliſhed and oiled, was driven in to open a paſſage; and then the cord was put through by the help of a poliſhed iron needle called *ramphis*, *Fig. CVI.* having a hole near the point, through which the end of the cord was paſſed; and a knob at the other end, upon which the hammer ſtruck to drive it through.

The cording being completed, ſome of what remained of the cord was tied around the tonus, and the reſt cut off. Then the end of the arm being introduced between the cords, the whole aſſemblage of cords was twiſted, by turning round the choenices with the wrench, *Fig. CIII.* as before explained in the deſcription of the baliſta. For wedging the cord in the choenices, the *periſtomis*, *Fig. CVII.* was uſed; it was a piece of wood about two or three palms long, having a cleft *a* in its ſide, juſt large enough to receive the cord. The periſtomis was laid on the choenicis, and the cord inſerted in the cleft, in which it was ſecured by a wedge *b*. The cord was uſually prepared ready for uſe, and wound around a wooden roller, called *epiſtomis*, *Fig. CVIII.*

Perrault, among many other remarks, obſerves that "it is difficult to comprehend how ropes of eight inches "thick, made of hair, ſhould yield a tone ſenſible to the "human ear." This remark aroſe from his idea of theſe engines: he imagined that it was the whole tonus, or complication of twiſted cords, that yielded the ſound; whereas it was each ſeparate cord of which that tonus conſiſted, as the foregoing account ſufficiently explains. The intention of this was, that every cord of the tonus ſhould be equally diſtended, and that the two hemitones ſhould be equal in power: for if one were ſtronger than the other, the arm it held would recoil quicker, and act upon the miſſile before the other arm arrived; by which means the

CHAPTER XIX.

Of Machines for Attack, and their Invention.

OF the foregoing things I have ſpoken what I could; it remains now to ſpeak of the machines uſed in attacks, with which generals conquer and defend cities: and firſt of the *Ram*, which is ſaid to have been thus invented:

When the Carthaginians were encamped to beſiege Cadiz, and had taken an advanced fort, which they endeavoured to demoliſh, having no iron tools, they took a beam and ſupporting it with their hands, they drove the end of it repeatedly againſt the top of the wall, throwing down the upper courſe of ſtones; and thus gradually, by courſes, deſtroyed the whole fortreſs. Afterward a certain ſmith of Tyre, named Pephaſmenos, excited by this invention, erected a maſt, from which he ſuſpended another tranſverſely, like a balance; and by drawing it back, and then impelling it forward, with the force of its blows he threw down the walls of Cadiz.[1*]

dart would be diſcharged by the force of one arm only, and would be diſcharged in an oblique direction.

The cords that formed the tonus were uſually made of the ſinews of animals: thoſe in the legs of deer, and in the necks of bulls, were recommended. But cords made of women's hair were moſt preferred, and accounted the ſtrongeſt.

When by frequent uſe the elaſticity of the tonus was weakened, it was in ſome degree recovered by turning round the choenices with the wrench, in the ſame manner as in the firſt forming it.

The antients had catapultæ and baliſtæ of conſtructions different from thoſe here deſcribed. Bito gives a deſcription of two ſuch engines, and ſays the place, purpoſe, and other circumſtances, often required a difference in their form: Philo alſo mentions many variations and improvements that he had made in the common conſtruction. The catapulta found by Lipſius in the armoury of Bruſſels, although very ſimilar to the ſort above deſcribed, had however many differences, with ſome of the improvements mentioned by Philo. The deſcriptions of Vegetius, and of Marcellinus, who lived many years after Vitruvius, ſhew that, in that interval, the forms as well as names of the military engines had undergone an alteration: thoſe authors call the engine that ſhot arrows and darts *baliſta*, and that which ſhot ſtones *onager*, from the animal of that name, which is ſaid to kick ſtones againſt the hunters who purſue it. Marcellinus alſo ſays the ſame engine was called *ſcorpion*, becauſe, like the inſect of that name, it held its ſting erect.

The power of theſe engines, according to the reports of the antient authors, muſt have been very great: Atheneus relates that a catapult aof only a foot in length was made to ſhoot an arrow half a mile; ſome, it is ſaid, would carry javelins acroſs the Danube. The baliſtæ diſcharged large beams of timber, ſpears of twelve cubits, and ſtones of 360 pounds weight. Polybius makes mention of ſtones being ſhot from baliſtæ to prevent ſhips entering a harbour.

Joſephus records many inſtances of their power—of their beating down the pinnacles and corners of towers, and overthrowing whole ranks of men—indicating a power almoſt equal to that of the modern cannons, which is ſcarcely credible.

(1*) Pliny, b. vii. ch. 56, ſays the *Ram* was invented at Troy; and it is thought it gave riſe to the ſtory of the wooden horſe, by the means of which the city was taken.

Cetras of Chalcedon was the firſt who made the timber baſe, with the wheels under it, and thereon raiſed arrectariæ (upright poſts) and forked yokes, on which he ſuſpended the ram[2*]; covering them with ox hides, that thoſe who were placed in the machine, to batter the walls, might be ſecure. This machine, becauſe it was ſlow in its operation, began to be called the Ram Tortoiſe[3*], and was the firſt example of theſe kinds of machines. Afterward, when Philip the ſon of Amyntas beſieged Byzantium, ſeveral other kinds, more ſimple, were invented by Polydus the Theſſalian; from whom Diades and Chereas, who were in Alexander's wars, received their inſtruction. But Diades in his writings aſſerts to have himſelf invented the moving towers, which he uſed to disjoin, and carry about with the army; as well as the borer, and the aſcending machine, which could be raiſed to the level of the walls; as alſo the demoliſhing crow, which ſome call a crane: he uſed alſo the ram upon wheels, the conſtruction of which he has left in writing.

Fig. CIX. The Tower, he ſays, ought to be made at leaſt LX. cubits high, in breadth XVII. and the contracture at top be a fifth part of the bottom; the arrectariæ of the tower ſhould at the bottom be three quarters of a foot, and at the top half a foot: in this tower, he ſays, may be ten ſtories, with apertures on the ſeveral ſides; but the larger tower

Fig. CX. ſhould be CXX. cubits high, and of cubits breadth XXIII. S. ⁘ the contracture at top alſo a fifth part ⁘. The arrectariæ ſhould be at bottom one foot, and at top half a foot. In towers of this magnitude, XX. floors are made; each floor having a circuition[4*] of three cubits. It is covered with raw hides, that it may be ſecured from all kind of projectiles.

Fig. CXI. The Ram Tortoiſe is conſtructed upon the ſame principle: it has an interval of XXX. cubits; the height, without the faſtigium (ſlope of the roof), XVI.; the height of the faſtigium, from the ſtratum (the uppermoſt level part) to the top, VII. cubits; alſo out of the middle of the roof a turret not leſs than XII. cubits broad riſes, and therein

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(2*) Atheneus, in his Treatiſe of Machines, aſſerts that Geras, a Carthaginian, was the inventor of the baſe. It has been ſuppoſed that Vitruvius has copied what he has written on this ſubject from Atheneus, or Atheneus from Vitruvius. But the latter expreſsly mentions, at the end of this chapter, that he has copied it from the writings of Diades, from whom perhaps Atheneus alſo copied; for he quotes that author, as Vitruvius alſo does, immediately before his deſcription. Repreſentations of the ram may be ſeen on the arch of Severus, and on the Trajan column, now ſtanding at Rome.

(3*) Vegetius ſays it was ſo called from its reſemblance to a tortoiſe with its head poked out of its ſhell.

(4*) What Vitruvius calls *circuition*, Atheneus calls *peridrome*. Perrault and Galiani ſuppoſe it to ſignify a fence or breaſtwork. Atheneus gives the height of the ſeveral ſtories, which are as follows: The 1ſt, ſeven cubits and a half; the 2d, 3d, 4th, and 5th, five cubits each; and all the reſt four cubits and a half each: the remainder of the meaſure of the height being occupied by the floors, baſe, wheels, and roof.

is raiſed four ſtories in height, in the upper ſtory of which the ſcorpions and catapultas are diſpoſed; in thoſe below a great quantity of water is collected, to extinguiſh fire if it ſhould happen to be thrown therein.

In this alſo was the ram machine, in Greek called *criodoche*, wherein were laid rollers perfectly turned, upon which was diſpoſed the ram; the drawing of which backward and forward with ropes, produced the great effect: this alſo was covered with raw hides, in the ſame manner as the tower.

Fig. CXII. Concerning the Borer he has given theſe rules in writing:—The machine is the ſame as the tortoiſe, having in the middle a ſtraight channel (*A*), like thoſe uſually made in the catapultæ or baliſtæ, of the length of L. cubits, and in height one cubit. In this is fixed a tranſverſe windlaſs (B), and at the end, on the right and left, two trochlea (ſheaves of pulleys), by which the beam, armed with iron at the part (*C*) that lies at the end of the channel, is moved. Under the ſame (beam), included within the channel, are rollers,[5*] which cauſe the motion to be quicker and more vehement; and over the beam that is therein are fixed arched ribs (*D*), to bear the raw hides (*E*) with which the machine is covered, to defend the channel.

Of the Crow he has not thought proper to write, becauſe he had obſerved this machine to be of no uſe.[6*]

Of the Acceſſus,[7*] which in Greek is called *epibathra*, and of the marine machines for

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(5*) In the text it is written *tuti*, which is corrected by De Lact to *tori:* for Atheneus, in this place, writes *cylindroi*; and at the place foregoing, where Vitruvius mentions *torus*, *cylindron*; ſo that, as the ſame thing is expreſſed by Atheneus, it is highly probable that the ſame thing is meant by Vitruvius, in both places; the rather as the correction agrees perfectly with the ſenſe and meaning of the context.

(6*) Apollodorus, Heron, and other antient authors, have deſcribed a machine of this name; and Polybius gives an account of one that was invented by the Romans at the time of their firſt naval engagement againſt the Carthaginians, with which they grappled the enemies ſhips, and by that means chiefly obtained the victory.

(7*) The commentators think the word *acceſſu* ſhould be written *aſcenſu*, ſuppoſing it to ſignify a machine for ſcaling the walls of a town; and Perrault, as well as Galiani, have ſo tranſlated it. But I find it plainly written *acceſſu* in all the manuſcripts I have ſeen: and it is well known that the antients had machines for gaining *acceſs* to the bottom of the walls, in order to undermine them, or fill up the ditches. Julius Cæſar mentions one that he uſed at the ſiege of Marſeilles, called a *muſculus*; and Vitruvius deſcribes one in the following chapter by the name of *teſtudo*, mentioning its uſe by the very words *acceſſus ad murum*. The antients, it is true, had alſo machines for ſcaling the walls; but ſince they had machines for both theſe purpoſes, there is no reaſon to ſuppoſe that the word that clearly expreſſes the one, ſhould have

boarding ſhips, he has only promiſed to treat; for I have not obſerved that he has deſcribed them.

I have mentioned what Diades has written concerning machines, and the manner in which they are prepared. I ſhall now explain ſuch others as appear to me uſeful, according as I have learnt them from authors.

CHAPTER XX.

Of the Teſtudo prepared for filling of Ditches.

Fig. CXIII. THE Teſtudo prepared for the purpoſe of filling ditches, and alſo to gain acceſs to the walls, is thus made:—A baſe (*ABCD*), which the Greeks call *eſchara*, is framed together: it is made ſquare, every ſide having XXV. feet, and four tranſverſe timbers; theſe are connected by two others, [1*] in thickneſs F. [2*] S. in breadth S. The tranſverſe pieces are about a

been originally written to ſignify the other. All the reaſon I can learn for this ſuppoſition of the commentators, is, that they believe it to be the ſame machine that Vitruvius has before mentioned in this chapter, by the words *aſcendentem machinam*; and they alſo ſuppoſe it to be the ſignification of the term *epibathra*, which Vitruvius ſays was the Greek name of the machine: but, at the 21ſt chapter following, Vitruvius uſes the word *arca*, which ſignifies ſome kind of incloſure, or ſhelter, or fence, for what Atheneus, in deſcribing the ſame object, calls *epibathra*. This therefore argues that that Greek word does not ſignify any kind of aſcending machine, as ſuppoſed, but ſome kind of teſtudo, or incloſed machine: and as Vitruvius here applies that word to the machine in queſtion, this, conjointly with the agreement of all the manuſcripts and editions of the text, amounts almoſt to a proof that the word *acceſſus* is in this place the original word, and that it ſignifies ſome kind of teſtudo or muſculus; not a ſcaling machine, as generally beleived.

(1*) This deſcription is not very intelligible; I have ſhewn my conception of it in *Fig. CXIII.* But Perrault and I underſtand it differently. The four tranſverſe timbers on every ſide, I ſuppoſe to mean the two inner and the two outer timbers which lie tranſverſely to the ſpectator, on whichſoever ſide he views the ſquare: the two other timbers, ſaid to connect them, I imagine to be diagonal pieces *EH* and *GF*; for ſuch diagonal pieces, though not particularly mentioned, are highly proper, and almoſt indiſpenſable, to preſerve ſuch a baſe, when in motion, in its true rectangular poſition. Apollodorus alſo, in the deſcription of the teſtudo, mentions ſuch diagonal timbers.

(2*) Meibonius thinks theſe characters F. S. ſhould be F. Z. becauſe the character ſignifying the greater proportion was uſually placed the firſt; Z. according to him ſignifying $\frac{4}{10}$, and F. $\frac{6}{10}$, whereas S. is univerſally allowed to ſignify $\frac{1}{2}$. But ſuch dimenſions appear to be too ſmall for timbers of the length deſcribed, and ſcarcely ſufficient to ſuſtain their own weight without bending in the middle; for which reaſon it is probable that the characters have been falſified and miſcopied. It is not unlikely that the text may have been originally written *craſſis I. S. latis I. S.* the *I* in the former being changed to an *F*, and

foot and S. aſunder; and in their intervals (*II*) are placed *arbuſculæ*, called in Greek *αμαξοτοδες*,[3*] within which the axes of the wheels, armed with iron plates, turn: and theſe arbuſculæ are prepared with turning joints, and have holes through which are paſſed levers to move them round; ſo that, by turning the arbuſculæ, the machine may be moved forward or backward, to the right or left, or obliquely to the angles, according as the work may require. Upon the baſe two beams (*KK*, *LL*) are laid, projecting on both ſides ſix feet; near the projecting ends of which, two other beams (*M*, *N*) are fixed, projecting before the fronts ſeven feet, as thick and broad as thoſe in the baſe.[4*] Upon this frame-work are erected the connected poſts (ϙ), being, excluſive of the tenons, IX. feet in meaſure, one foot and a palm on every ſide; and being at intervals (*R*) of a foot and a half:[5*] theſe are ſecured at the top by the mortiſed beams (*S*). Upon the beams are placed the capriols[6*] (*T*), mortiſed and

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in the latter omitted; for a foot and a half in breadth and thickneſs would not have been more than ſufficient for timbers of their length and purpoſe.

Perrault has interpreted F. S. the eighteenth part of the length of the timbers; by which he makes their thickneſs a little more than a foot and one third, which is a meaſure certainly more ſuitable: but on what authority he has done this, does not appear; for in the next chapter he has given F. the value he uſually allows it, *viz.* the $\frac{1}{12}$ of a foot, tranſlating F. Z. the $\frac{1}{12}$ and the $\frac{1}{8}$ of a foot.

(3*) The *arbuſculæ*, becauſe the word ſignifies *little trees*, are generally ſuppoſed to have been cylindric pieces of timber, having a cleft at the bottom to admit the wheel. But, at the following chapter, the wheels that were ſet in the arbuſculæ are ſaid to have been three feet thick, and nearly ſeven feet in diameter: it muſt have been an uncommonly large and enormous tree to have been of ſufficient diameter to receive ſuch a wheel within its body; and alſo to have ſubſtance enough left on each ſide to receive the axis of the wheel, and conſequently to ſupport the weight of the whole machine, as well as its lateral preſſure when in motion.

Trees of ſuch a magnitude could not always be procured; and, if they could, it would not be expedient or mechanical to uſe ſuch a ſolid maſs of timber, when a frame of the ſize required would anſwer the purpoſe better, as being lighter, more manageable, and equally ſtrong. For theſe reaſons I am compelled to differ from former commentators in my idea of the arbuſculæ. I have ſhewn my idea by *Fig. CXIV.* It conſiſts of a ſquare horizontal frame *AB*, having on the right and left ſides perpendicular pieces *F*, ſecured by braces *G:* theſe include the wheel *H*, and receive its axis.

In the middle of the frame is a perpendicular column or tree *C*, being quadrangular at the part *D* that enters the frame, and cylindrical above: this cylindrical part paſſes upward into the teſtudo, through the circular intervals *II*, *Fig. CXIII.*; ſo that, by inſerting levers *E* in holes bored in the cylindric part, the arbuſculæ might be turned by the men in the teſtudo to the direction required.

The arbuſculæ and wheels were defended from the power of the miſſiles by the ſides of the teſtudo projecting before them, as Vitruvius preſently mentions.

Perrault obſerves that this was a neceſſary precaution; and relates that, at the ſiege of Oſtend, an engineer made a machine in imitation of the teſtudo of the antients, which, for want of ſuch defence, was ſoon rendered uſeleſs, a cannon-ball breaking one of the wheels: nevertheleſs Perrault has repreſented the wheels expoſed in the draught of all the machines he has given.

(4*) There muſt be yet two more beams *OP*, which Vitruvius does not mention; theſe muſt lie on, or be framed into, the projecting ends *V* of the latter two beams *MN*, to ſupport the poſts on thoſe ſides of the teſtudo; for all the four ſides projected ſeveral feet before the front of the baſe, in order to defend the wheels, and the men who worked them, from the miſſiles of the enemy, as before obſerved.

(5*) In Galiani's tranſlation this is inadvertently written *mezzo piede*, half a foot—inſtead of *un piede & mezzo*, a foot and a half—and it is not corrected in the errata.

(6*) *Capriols* here ſignify what are before called *canthers*, being the rafters or timbers that form the inclined ſides of the roof.

tenonted one into the other, riſing in height IX. feet. On the capriols is laid a ſquare beam (*U*), by which the capriols are connected: they alſo are ſecured with lateraria[7*] fixed all over them, and are covered with planks of the palm-tree; or, if not of that, of ſome other wood that has the proper qualities: excluding, however, pine or alder; for theſe are weak, and eaſily take fire. All over the planking[8*] are laid gratings, made of ſlender twigs, thickly interwoven together, and being green. Then with doubled raw hides ſewed together, and ſtuffed with ſea-weeds, or ſtraw macerated in vinegar, the whole machine is covered over; ſo that it may be ſecured againſt the attacks of the baliſtæ, and the effects of the firebrands.

CHAPTER XXI.

Of other Kinds of Teſtudos.

Fig. CXV. THERE is another kind of Teſtudo, that has all the parts the ſame as that before deſcribed, except the capriols; inſtead of which it has all round it a parapet, and pinnæ[1*] (*A*) made of boards; and at the top declining eaves (*B*), firmly connected by means of boards, and ſkins fixed thereon. Upon theſe alſo clay mixed with hair is laid, to ſuch a thickneſs as may prevent the machine from being endangered by fire. Theſe machines may have eight wheels, if the nature of the place will admit it to be ſo prepared.

Fig. CXVI. Thoſe Teſtudos that are made for undermining, are called in Greek *oryges*; they are the ſame as thoſe above written, excepting that their fronts are formed like equilateral triangles (*A B C*), that the miſſiles from the walls that are ſhot againſt them may not be received on a flat front, but be ſlanted off ſideways, that the diggers who are within may be ſecured from danger.

(7*) Theſe *lateraria* are mentioned again in the next chapter; they were, very likely, *planks* fixed tranſverſely on the rafters of the roof.

(8*) Perrault has tranſlated "tabulata," *les coſtes*, i. e. *the ſides*; becauſe he ſays *that word ſignifies a floor, which the teſtudo had not:* but it here evidently means the planks or boards with which the capriols were covered.

(1*) The *pinnæ* here probably mean what we call *battlements*.

Fig. CXVII. It ſeems to me alſo not improper to ſpeak of the Teſtudo that Agetor[2*] the Byzantine made, and the manner in which it was conſtructed. The baſe (*ABCD*) was in length LX. feet, in breadth XVIII.[3*] The four *arrectaria*[4*] (*E*) that were placed on the frame, were formed out of two beams, each being in height XXXVI. feet, in thickneſs a foot and a palm, and in breadth a foot and a half. The baſe had eight wheels (*FF*), upon which it was moved; their height was VI. S: — feet,[5*] their thickneſs three feet; and were thus made out of triple timbers united one to the other with dovetails, and ſecured with iron plates cold-worked. Theſe had a rotation in arbuſculæ, or, as they are called, *amaxopodes*.

Upon the plane (*HIKL*) of the trantræ, or *tranſverſe beams* (*GG*), that were laid on the baſe, were erected poſts (*M*) of XVIII: — feet; being in breadth: — S. in thickneſs F. Z. diſtant from each other I. S: —.[6*] Over theſe were the circumcluding beams (*N*) that con-

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(2*) Written in ſome manuſcripts *Hector*, and *Hegetor*.

(3*) Atheneus and Heron, who deſcribe this teſtudo of Agetor, ſay the length of the baſe was 42 cubits, and the breadth 28 cubits: ſo that the length Vitruvius mentions, *viz.* LX. feet, may be right; for as the Greek foot was about $\frac{1}{24}$, or half an inch, ſhorter than the Roman foot, 42 cubits will make about 60 feet 5 inches and a half of Roman meaſure. But the latter number in Vitruvius (XVIII.) may probably be erroneous, as it ſeems too ſmall for the uſe the teſtudo was to ſerve; and that meaſure in which both Atheneus and Heron agree, *viz.* 28 cubits, is probably the right.

(4*) Where theſe four *arrectaria* were placed, or what purpoſe they ſerved, is not explained: they did not ſupport the roof; for others, XVIII. feet high, are hereafter allotted to that office. It is not mentioned whether the two beams from which they were formed were joined together ſide by ſide, or at their ends, forming together a poſt of about 72 feet in length. But I am induced to determine, from many circumſtances, for the latter; and that they were the poſts *EE*, *Fig. CXVII.*

There are many other parts of this teſtudo that are not ſufficiently explained, ſo that it becomes difficult to conceive its entire conſtruction; and the tranſlators have omitted giving any delineation of it.

Atheneus deſcribes it, but almoſt as obſcurely as Vitruvius. A ram is hereafter mentioned; but it is not ſaid whether or not it was united with the teſtudo, or where or how it was diſpoſed. Rams, when joined to teſtudos, were uſually placed within them, that the men who worked the ram might be ſheltered and defended by the roof of the teſtudo. But this ram could not be ſo diſpoſed—1ſt, becauſe the timbers that ſupported it are deſcribed to be ſeveral feet higher than the roof of the teſtudo: and, 2dly, if ſo ſituated, it could not reach to batter the wall ſo high, or ſo far ſideways, as is mentioned; for the breadth and height of the teſtudo would not admit it. Theſe were ſome, among many other difficulties, that impeded the conception. But the ſketch annexed to Heron's deſcription, in which the ram appears to be ſuſpended above the roof of the teſtudo, although it is not ſo expreſſed in the deſcription, contributed to form the idea.

(5*) Perrault has interpreted the characters VI. S: — five feet and three quarters. They evidently ſignify ſix feet, and the portion meant by the mark S: —, which is generally believed to ſignify three quarters of the foot, the integer named. Atheneus ſays they were four cubits and a half, which equals ſix feet and three quarters exactly.

(6*) Atheneus ſays theſe poſts were twelve cubits long, three palms in breadth, and ten digits in thickneſs, and diſtant from each other ſeven palms; ſo that he agrees with Vitruvius in all the meaſures except the length, which Vitruvius makes more by the character: —. But as that meaſure is written differently in different manuſcripts of Vitruvius, that of Atheneus is more to be depended on. This agreement however of the two authors, in all the other meaſures, confirms the opinion that the character S: —, or: — S, ſignifies three quarters of the integer named; S. ſignifying a half, and: — a quarter: but it entirely diſproves the uſual acceptation of the characters F. Z. which have been ſuppoſed to ſignify $\frac{1}{12}$ and $\frac{1}{3}$ of a foot, that is, two inches and a half; a meaſure

nected the whole frame [7*] being I: — foot broad, and S: — thick. Upon this the capriols (*O*) were raiſed in height XII. feet. On the capriols a beam (*P*) was laid, that united the framing of the capriols. They had alſo lateraria [8*] fixed tranſverſely, the boarding upon which covered all the inferior parts. It had likewiſe a middle floor, ſupported upon little beams, wherein the ſcorpions and catapultas were placed [9*]. And two compact arrectaria (*Q*) were erected, being in height feet XXXV. [10*] in thickneſs a foot and a half in breadth II. feet, conjoined at their tops with a tranſverſe mortiſed beam (*R*), and with another (*S*) tenonted in the middle between the two ſhafts, and faſtened with iron plates. There was moreover placed a moveable timber, laid acroſs within the ſhafts and the tranſverſe piece, firmly held by chelonia and ancons [11*]. In this timber were two turned axles, from which the ropes (*T*) ſupported the ram (*UV*). Above the top of theſe, that ſupported the ram [12*], was placed a *plu-*

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much too ſmall for the thickneſs of the poſts, which Atheneus ſays was ten digits, or ſeven inches and a half. Theſe characters F. Z. therefore agree with the explication of Meibonius, given in the table of characters at the 15th chapter foregoing.

(7*) The marks and , in ſeveral places of this and other chapters, appear to be not uſed as the ſign of any number or meaſure, but rather as ſtops or periods of the diſcourſe. Perrault however has thought differently, and has invariably tranſlated them as ſignifying the fraction $\frac{1}{9}$ of the integer, wherever they have occurred. I have endeavoured to keep them in the tranſlation in the ſame ſituation as in the original, which is the reaſon the name of the integer is ſometimes placed before the number, or character, inſtead of being after it.

(8*) The *lateraria* are explained in the foregoing chapter.

(9*) Atheneus ſays this middle floor was placed upon the circumcluding beams before mentioned, which he calls *epiſtylia*.

(10*) The height of theſe *arrectaria*, according to Atheneus, was thirty cubits, equal to XXXXV. feet; it may therefore have been originally written XXXXV. by Vitruvius, and the copyiſts have omitted an X.

But in the breadth of theſe arrectaria Atheneus is probably wrong; for he makes it but three palms, although he agrees with Vitruvius in the thickneſs being a foot and a half: and as it is not likely that that meaſure of the timber which is called its breadth ſhould be leſs than that which is called its thickneſs, I am induced to think that Atheneus may be, in this place, corrupted. Vitruvius does not inform us where theſe arrectaria were raiſed; but Atheneus ſays it was in the middle of the teſtudo.

(11*) "Quo inſuper collocata erat alternis materies "inter ſcapos et tranſverſarium trajecta." The words *alternis materies* have been rendered by the tranſlators *alternate timbers*; but the preceding word *erat*, plainly indicates that they relate to a ſingle object: and this is confirmed by Atheneus, who mentions it as a ſingle piece of timber; ſo that the word *alternis* muſt here ſignify that the ſaid piece was moveable, and could be placed alternately in different ſituations, higher or lower; thus raiſing or lowering the ram, which was ſuſpended thereto. Perrault's idea of two ranges of holes, like thoſe in the frames for embroidery, ſeems totally inapplicable, and unauthorized by the text.

This moveable timber is ſaid to have been placed between the ſhafts and tranſverſe piece; which, as Perrault obſerves, is not poſſible, becauſe thoſe two parts join: but the meaning (in my idea) is, that the ſaid moveable timber was placed within the ſpace circumcluded by the ſhafts and tranſverſe piece; the word *inter* being ſometimes uſed by Vitruvius in that ſenſe, as was before noticed at the 6th chapter of the 8th book.

(12*) "Supra caput eorum qui continebant collocatum "erat pluteum." Theſe words have alſo been generally rendered, "Over the head of thoſe who managed the ram, "was placed a pluteum:" but Atheneus ſays it was placed above the *criodoke*, or beam that ſupported the ram; and Heron's ſketch and words deſcribe it to be upon the top of the front of the tower. The word *eorum* therefore

teum (*W*), faſhioned like a little tower, wherein two ſoldiers could, without danger, ſtand to obſerve and give notice of the enemies attempts. The length of the ram was feet CVI. ⁝⁝ the breadth at bottom, a foot and a palm ⁝⁝ the thickneſs a foot [13*] ⁝⁝. It was diminiſhed at the head, being in breadth I. foot ⁝⁝ and in thickneſs S. :—. This ram had alſo a roſtrum (*V*) of hardened iron, ſuch as war ſhips uſually have; and from this roſtrum extended four iron bars (*Y*) about fifteen feet [14*], which were fixed to the timber: from the head alſo to the lower end of the beam were ſtretched four ropes, eight digits in thickneſs, bound in the ſame manner as the maſt of a ſhip is bound from the poop to the prow [15*]; and theſe ropes were faſtened with tranſverſal ropes, a foot and a palm diſtant from each other [16*], and then the whole ram was covered with raw hides: alſo at the upper ends (*T*) of the ropes by which it was ſuſpended [17*], were four iron chains, and theſe were alſo covered with raw hides.

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muſt allude to the axles (that ſupported the ram) which Vitruvius has juſt mentioned, and not to the men who worked the ram; for, ſhould the pluteum have been placed juſt over thoſe men's heads, it muſt have been an impediment to the ram's motion.

(13*) As Atheneus ſays the thickneſs of the ram was two feet, Meibonius ſuppoſes that, inſtead of *craſſitudine pedali*, Vitruvius wrote *craſſitudine bipedali*. But Heron agrees with Vitruvius in allowing the thickneſs but one foot: and all theſe authors agree in its meaſure at the head; where, according to Heron and Vitruvius, it was diminiſhed a quarter of a foot in breadth and thickneſs. This therefore, together with the impropriety of expreſſing the thickneſs to be greater than the breadth, renders it probable that the error is not in Vitruvius, but in Atheneus.

Both Heron and Atheneus ſay the length of the ram was 120 cubits.

(14*) "Ex ipſo roſtro laminæ ferreæ quatuor circiter "pedum XV."

Perrault has tranſlated this paſſage thus: "From the "ſaid head proceed four plates of iron, about four feet "long." And by his notes it appears that he has ſuppoſed the word *quatuor* to relate to *pedum*, making the numerals *XV.* to ſignify $\frac{1}{15}$ of a foot more: ſo that he ſeems not to have been aware that he has uſed the ſame word *quatuor* twice in the ſame ſentence; for he has applied it firſt to *laminæ ferreæ*, ſaying *four iron plates*; and then again to *pedum*, ſaying *four feet*.

Galiani notices Perrault's improper application of the word *quatuor* to *pedum*; but has not obſerved that he has uſed it twice, by applying it alſo to *laminæ ferreæ*. As it has been the conſtant practice of Vitruvius throughout the whole work, and often repeated in this chapter, to expreſs the quantity or number by numeral letters placed after the name of the integer, there can be no reaſon to doubt that in this inſtance (which is analogous to all the reſt) he follows the ſame method.

Theſe numerals *XV.* therefore undoubtedly relate to *pedum*, and expreſs the number of feet the iron bars were in length; as *quatuor* does to *laminæ ferreæ*, to denote the number of thoſe iron bars: and, to confirm this, both Atheneus and Heron agree in expreſſing the number of the iron bars to be four; and their length to be ten cubits, which is XV. feet exactly.

(15*) This paſſage excites an idea that the ropes extended from the top of the arrectaria to each end of the ram, the two ends of which anſwering to the poop and prow of the veſſel, and the arrectaria to the maſt. But the words of Heron and Atheneus do not encourage ſuch an idea; they only import that the ram was girt around with the ropes, which, according to them, were in number *three*, although Vitruvius writes *four*.

(16*) Atheneus and Heron deſcribe theſe tranſverſal bands to be applied only at the middle part of the ram, and the number of them to be four; ſo forming three intervals, from which the four ropes *T X*, that ſupported the ram, extended up to the turned axles before named at the top of the arrectaria: thus having ſome reſemblance to the manner in which the maſt of a ſhip is bound from head to ſtern.

(17*) Vitruvius has not clearly expreſſed what ropes he here means; but we learn from Atheneus that they were the ropes *T X* that hung down from the before-named axles, and ſupported the ram. Atheneus adds, that the chains with which the tops of them were bound were covered with raw hides, ſo that they could not be ſeen.

The projecture of it had a compact and fixed area of boards, with large ropes extended; the roughneſs of which preventing the feet from ſlipping, it was more eaſily brought to the wall.[18*] This machine could be moved in ſix manners: progreſſively, alſo to the right and left ſides; by means of its extenſion it could be raiſed upward, and declined downward.[19*] The machine could be elevated, to demoliſh a wall, about an C. feet in height[20*]; it alſo could reach to the right and left ſides not leſs than an C. feet: it was managed by an C. men; and had the weight of four thouſand talents, which is equal to CCCCLXXX. (thouſand) pounds.[21*]

(18*) It is uncertain what part is meant by the *projectura*, which Atheneus calls *proſphora*, whereon the arca, or incloſure of boards, was fixed. By Heron's ſketch it ſhould ſeem to be the projecting end of the ram itſelf; for the large ropes (or net, *a*, *b*, as Heron and Atheneus call it) appear to hang therefrom. But the projecting end of the ram itſelf ſeems a very improper place for an incloſure of boards to be fixed on; as the concuſſive motion of the ram muſt ſhake it to pieces, how ſtrongly ſoever it might be connected. I cannot ſatisfy myſelf with any conjecture concerning it; but am moſt inclined to believe the *projectura* to have been a kind of drawbridge, united to ſome part of the teſtudo: for ſuch bridges were not uncommon in this kind of machines; they being kept in a perpendicular ſituation againſt the ſides of the teſtudo or tower till wanted, when they were let down by ropes, ſo as to project in a horizontal poſition on to the enemies walls, as ſoon as a breach had been made therein by the battering ram.

On ſuch a bridge the arca of boards might have been diſpoſed, to ſhelter the men, when croſſing thereon to the walls of the enemy.

(19*) The text ſays "this machine was moveable in "*ſix manners:*" but Perrault tranſlates it, *three manners*; for he ſuppoſes the number to have been written in numerals thus *III.* and that the copyiſts have miſtaken it for *VI.* But I find it expreſſed by the word *ſex* in all the manuſcripts and printed copies I have examined, and therefore not likely to have been ſo altered. Atheneus alſo agrees with Vitruvius in this circumſtance, and ſpecifies the ſix movements thus: 1ſt, *forward*; 2d, *backward*; 3d and 4th, *to both ſides*; 5th, *upward*; and 6th, *downward*.

Theſe perhaps may not be admitted to be more than three diſtinct movements; but they may have been ſix in the idea of Vitruvius, to whoſe idea it is proper that the explanation ſhould conform.

(20*) At this place alſo Perrault believes there is an error. It is ſaid the "ram could be elevated, to demoliſh "a wall, to an hundred feet in height." This height Perrault thinks the ram could not reach, the teſtudo under which it was placed not being a third of that height. Nevertheleſs, Vitruvius's words are confirmed by both Heron and Atheneus; ſo that it is not probable that the text is here erroneous. There is a reaſon for the ram being able to reach ſo high, that Perrault ſeems not to have had an idea of; which is, that it was ſuſpended above the roof of the teſtudo, not within it, as he ſuppoſes. There may be another reaſon alſo, not explained by Vitruvius: this is, that the ropes that ſupported the ram might not be fixed exactly at the middle of it, but nearer to its end, where, for a counterpoiſe, was fixed a great weight *U*; this being a method uſually practiſed, as Apollodorus aſſerts: by theſe means the ram would not only reach to a greater diſtance and height, but alſo its momentum would be conſiderably increaſed.

(21*) In writing theſe numerals CCCCLXXX. it is ſuppoſed the copyiſts have omitted the line over them, placed thus $\overline{\text{CCCCLXXX}}$. which was a mark the antients uſed to ſignify thouſands; the numbers it was applied to then expreſſing as many thouſands as without it they ſignified units: for the talent, although it differed in different countries, was however in ſome countries reckoned at 120 pounds; at which rate 4000 talents equal 480,000 pounds.

In one of the manuſcripts at the Britiſh Muſeum the numerals are really written with the line over them.

CHAPTER XXII.

Of Things relative to Defence.

OF the Scorpions, Catapultæ, and Baliſtæ, as alſo of Tortoiſes and Towers, by whom they were invented, and how they ſhould be conſtructed, I have diſcourſed ſo far as appeared to me proper. But of the Scalæ (ladders) and Carcheſia[1*], and thoſe things of which the principles are more ſimple, it is not neceſſary to write; for theſe the ſoldiers themſelves uſually make. Nor can they in all places be of the ſame conſtruction; becauſe fortifications from fortifications, and the courage of nations, are different: ſome machines ſhould be ſuited to the bold and daring, others to the diligent, and others again to the timid. Whoever therefore will attend to theſe precepts, ſelecting from their variety, and combining them together in one compoſition, will not want other aſſiſtance; but whatever the caſe, or the circumſtances, or the nature of the place may require, he will without doubt be able to perform.

Of defenſive machines it is not poſſible to give an explication in writing: for the enemy make not their military weapons like ours; and their devices are oftentimes, by a ſudden ingenious thought, without machines, fruſtrated. Thus it is reported to have happened with the Rhodians. Diognetus was a Rhodian architect, who was paid a fixed annual ſalary from the public, to honour him for his ſkill. At that time a certain architect from Aradus, named Callias, arrived at Rhodes, obtained an audience, and produced a model of a wall, with a machine in a verſatile carcheſium fixed thereon, by which he could ſeize an *helepolis*[2*] approaching the fortification, and transfer it within the walls. When the Rhodians ſaw this model, in their admiration they took from Diognetus his eſtabliſhed ſalary, and conferred that honour upon Callias.

About that time king Demetrius, who for his firmneſs of mind was called Poliorcetes[3*], preparing for war againſt Rhodes, took with him Epimachus, a famous Athenian architect, who with great labour, and at an immenſe expence, prepared an helepolis, whoſe height was

(1*) The carchefia are ſpoken of at the fifth chapter foregoing.

(2*) Signifying a machine for the attack of cities.

(3*) A city-beſieger. The hiſtorians ſay Demetrius was ſo called from the number of cities he beſieged, and from his perſevering in the ſiege till he had conquered.

CXXV. feet, and breadth LX feet[4*]; which he ſo ſecured with hair-cloths and raw hides, that it could withſtand the blow of a ſtone, ſhot from a baliſta, of CCCLX. pounds. The machine itſelf was (in weight) CCCLX. thouſand pounds. When Callias was required by the Rhodians to prepare his machine againſt this helepolis, and transfer it, as he had promiſed, within the walls, he declared he could not: for all machines cannot be formed upon the ſame principles; and there are ſome that have effects in models, the like of which in the large cannot be produced; and others cannot admit of any model, but muſt be themſelves executed: ſome alſo there are that in models appear very ſpecious, but when executed at large are uſeleſs, as we may obſerve by this inſtance. So a hole of half a digit, a digit, or even a digit and a half, may be bored; but if by the ſame means we would make one of a palm, it is not to be done; one of half a foot or more ſeems not even to be thought of: ſo that what in ſmall works appears poſſible, in very great is found to be impracticable; much leſs can the ſame methods be practiſed in yet greater works. When the Rhodians, who had done this injury and diſhonour to Diognetus, perceived that they were by theſe principles deceived; and ſaw the enemy determined to inveſt them, and the machine prepared to take the city; dreading the danger of ſlavery, and expecting nothing but the deſtruction of their town, they humbled themſelves to Diognetus, entreating him to aſſiſt his country. This at firſt he refuſed; but afterward, when the delicate virgins and youths, accompanied with the prieſts, came to ſolicit him, he then promiſed it, upon theſe conditions—that, if he took this machine, it ſhould be his own. This being agreed to, he broke through that part of the wall to which the machine approached; and ordered all the people, public and private, to pour through channels made in this aperture whatever water, dung, or mud they had, before the wall. In the night a great quantity of water, mud, and dung being there diſcharged, on the following day, when the helepolis approaching came near to the wall, it ſunk in this humid quagmire; nor could it afterward be moved forward or backward. When therefore Demetrius ſaw himſelf overreached by the ſagacity of Diognetus, he with his fleet departed. The Rhodians then, delivered from the perils of war by the ingenuity of Diognetus, returned him thanks in public, and beſtowed on him all (kinds of) honours, and ornaments of diſtinction. Diognetus then brought the helepolis into the city, ſituated it in a public place, and thus inſcribed it:—*Diognetus gave this preſent to the people, out of the ſpoils of war.*

(4*) Plutarch, in the life of Demetrius, deſcribes this *helepolis* to have been a ſquare tower, diminiſhing toward the top, being 48 cubits broad, and 90 in height; containing nine ſtories, and moveable upon wheels. It may have been a tower of that kind that contained a ram in the lower part, deſcribed by Vitruvius in the 19th chapter of this book.

Thus, for defenſive purpoſes, we may obſerve it is not ſo much machines as ſtratagems that are to be made uſe of. So at Chios, when the enemy had prepared their *ſambucæ*[5*] on board their ſhips, the Chians in the night threw earth, ſand, and ſtones, into the ſea, before the wall; ſo that, when they attempted to approach it the following day, the ſhips grounded upon the heap that was under the water, and could neither approach the wall nor return back, but were with flaming *malleoli*[6*] there conſumed.

At Apollonia alſo, when it was beſieged, and the enemy by digging a mine thought to enter the fortifications without ſuſpicion, the Apollonians, being apprized of it by their ſpies, were diſordered by fear at the news, were weak in their councils, and confuſed in their minds; for they knew not at what time or place the enemy would enter. Then Tryphon of Alexandria, who was the architect there, marked out many caverns within the walls, and digging out the earth, proceeded without the wall as far as the ſhot of an arrow, where in all of them he ſuſpended braſs vaſes: in one of theſe caverns, that was oppoſite to the mine of the enemy, the ſuſpended vaſe began to ſound at the blows of the iron tools; and by this it was known at what part the enemy were working the mine, and intended to penetrate. The ſituation being thus diſcovered, he prepared caldrons of boiling water and pitch, with human dung, and heated ſand, in a place that was over the heads of the enemy: then in the night boring a number of holes, through theſe he ſuddenly poured the mixture; and thus deſtroyed all the men who were at work in the mine.

When Marſeilles likewiſe was beſieged, and there were upwards of thirty mines dug, the inhabitants ſuſpecting it, ſunk the ditch before the wall deeper, ſo that all the mines terminated in the ditch. But, in the places where there was no ditch, they dug a pond within the walls, very long and broad, like a fiſh-pond, oppoſite to the mine, filling it from wells or from the port. As ſoon therefore as holes were opened, the water ruſhing in with great

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(5*) Machines to ſcale the walls; ſo called from being ſhaped like the muſical inſtrument of that name, ſpoken of at the 1ſt chapter of the 6th book, where it is ſignified to be of a triangular figure. Vegetius, l. iv. ch. 21, ſays, "This machine is ſo called from its ſimilitude to a cythara; "for as the ſtrings are diſpoſed in a cythara, ſo are the "ropes in the beam that is put againſt the tower, the "beam having pulleys at the upper part." It is probable therefore that this machine was a ladder, narrow at the top, and broad at the bottom; the ſteps of which were formed of ropes, that were connected by other perpendicular ropes on each ſide, paſſing round the pulleys at the top, and by that means being drawn up. Plutarch ſays, Marcellus was the inventor of the ſambuca.

(6*) Theſe *malleoli* were arrows, having combuſtible compoſitions fixed to them; they were ſhot againſt the objects they wanted to burn.

The combuſtible compound uſed was in aftertimes called the Greek fire; which burnt ſo intenſely, that it is ſaid it could not be extinguiſhed but by vinegar mixed with ſand and urine.

violence, threw down the props; ſo that all who were therein were overwhelmed by the quantity of water, and ruins of the mine.—When a rampart alſo had been prepared with trunks of trees oppoſite to their walls, they, by throwing againſt it from their baliſtæ red-hot iron bars, conſumed the whole. And when the ram tortoiſe approached to batter their wall, they let down a rope with a nooſe to it, and with this bridled the ram: then, winding the rope round a wheel by means of a capſtan, they held its head ſuſpended, ſo that it could not touch the wall; and at laſt, with burning malleoli ſhot from the baliſtæ, they deſtroyed the whole machine. Thus theſe cities obtained the victory, and were preſerved, not by the help of machines, but by the ſkill of their architects oppoſed to the power of machines.

Of the conſtruction of ſuch machines for peace and war as I have judged the moſt uſeful, I have, as well as I have been able, treated in this book; and I have, in the preceding nine, diſcourſed of the ſeveral other parts of architecture: ſo that the whole work might, in ten books, explain all the branches of the art.

THE END.

APPENDIX.

BOOK II. Ch. III. IN my tranſlation of the paſſage of Vitruvius concerning the ſize of the Roman bricks called *didoron*, I followed the text of the common printed editions, as all former tranſlators have done. Since, upon obſerving the proportions given by Pliny to be very different, I have been induced to conſult the manuſcripts; and, in all I had opportunity to examine, I found the ſize to be the ſame as that reported by Pliny, and different from that given in all the printed editions. In the editions they are ſaid to be one foot long, and half a foot broad; in the manuſcripts, one foot and a half long, and one foot broad. Inſtead alſo of the name *didoron*, the manuſcripts have it *lydium*; not *lichum*, as Philander reads it (probably by the ſemblance of the letters). The paſſage in the manuſcripts runs thus:—Fiunt autem laterum genera tria: unum quod Græcè *lydium* appellatur, id eſt quo noſtri utuntur, longum ſeſquipede, latum pede.

This meaſure of the Roman bricks agrees with many which remain (allowance being made for the different ſhrinking of different earths) as in the Portico of Octavia, and other ruins at Rome, and in ſome remains of Roman buildings in this iſland. (See Archæologia, vol. iv. p. 88.) The ſame ſize is alſo allowed them by Alberti in his treatiſe of Architecture, book ii. ch. x.; by the anonymous antient author in Polenis Exercitationes Vitruvianæ; and by Grapaldi De Partibus Ædium: this latter ſays the bricks were called *lydoron*, or *didoron*. The Vatican manuſcripts quoted by Galiani agree likewiſe in the ſame meaſure.

But the term *didoron*, which ſignifies *two palms*, does not ſeem applicable to bricks that were a foot and half, or ſix palms, long: to make it apply, ſome commentators have alleged that the major palm of $\frac{3}{4}$ of a foot is to be underſtood in this kind of bricks. But it appears not ſatisfactory that we ſhould underſtand the ſame term *doron* to ſignify in one kind the major palm, and in the other kinds the minor palm; and that the kind called the two palm bricks ſhould be larger than thoſe called the four and five palm bricks.

The letters of the antient manuſcripts are very eaſily miſtaken, and the words are thus converted into others: if we might ſuppoſe that *lydoron*, according to Grapaldi, was originally written, or rather *polydoron*, many palms, the two firſt letters being careleſsly omitted, the term would then well agree with the kind of bricks deſcribed by it.

From the foregoing obſervations, I am for altering the paſſage of my tranſlation in queſtion, thus: inſtead of *a foot long, and half a foot broad*, read *a foot and half long, and a foot broad*; and inſtead of *didoron* read *lydoron* or *polydoron*.

Pliny alſo differs from Vitruvius in the ſize of the bricks called *tetradoron* and *pentadoron*, which the latter deſcribes as being ſquare; whereas the former ſays, all the kinds of bricks were of the ſame breadth, and differed only in their length.

N. B. Note (2) of this chapter, ſo far as it regards the ſizes of the bricks, will require to be corrected in conſequence of theſe obſervations.

APPENDIX.

There are ſeveral paſſages in this and other chapters which indicate that the bricks ſpoken of were not burnt, but dried only. Vitruvius mentions the ſtraw uſed in them not adhering in ſome kinds of earth; of their ſhrinking after they are laid in the building, if the inſide be not ſufficiently dried; and of their requiring at leaſt two years to dry: and at Chapter VIII. he ſays, the tops of the walls ſhould be covered with teſtaceous ſubſtances, to prevent the rain, if it ſhould penetrate through the roof, from injuring the bricks in the wall. The teſtaceous ſubſtance meant was probably ſome kind of burnt earth, as obſerved at note (8) of that chapter: and, if the bricks were alſo burnt, there could be no reaſon for the caution, ſince the rain could no more injure one than the other. The non-adheſion of the ſtraw could not be mentioned in burnt bricks; nor the being dry without ſide, and not within; and ſhrinking, from that cauſe, after they were laid in the wall. It ſeems probable therefore that the antients, ſometimes at leaſt, uſed unburnt bricks, perhaps in the ſmaller houſes of private citizens; and theſe are what Vitruvius means by the word *later*, diſtinguiſhing the burnt ſort by the term *teſta*, or *later coctus*.

BOOK III. Ch. III. Note (15). It is in this note obſerved, that ſome commentators have judged that Vitruvius preſcribes too large a proportion for the receſs of the cathetal line from the extremity of the abacus of the Ionic capital, and have therefore thought his text was corrupted; but, in proof of its purity, there are remains of ancient Greek buildings ſtill ſubſiſting, wherein this rule of Vitruvius is exemplified, *viz.* the temple of Apollo near Miletus, and the Ionic temple on the Iliſſus at Athens; in both of which examples the cathetal line of the capital recedes from the abacus as much as Vitruvius preſcribes.

It may be worth obſervation, that the baſes as well as capitals of the columns of the ſaid temple at Miletus agree very nearly, in form and proportion, with the deſcription that Vitruvius gives of the Ionic baſe and capital; from whence it may be inferred, with ſome probability, that they were wholly formed on the rules he has tranſmitted to us; and that the volute may be conſidered as the true Vitruvian volute, the conſtruction of which ſo many ingenious perſons have employed themſelves to diſcover.—A repreſentation of it may be ſeen in the Ionian Antiquities.

BOOK III. Ch. III. Note (16). In confirmation of the reaſoning of this note, as well as to ſhew that the text is in this place probably authentic, the antient Greek temple on the Iliſſus at Athens may be produced as an example; for, in this building, the abacus of the capital is in length and breadth equal to a diameter, and about one ninth, of the bottom of the column; and the height of the ſaid column is fourteen feet eight inches, Engliſh meaſure. So that it becomes highly probable that Vitruvius intended the abacus to be of this proportion, in columns of the height of fifteen feet and under, as argued in the note; and the former meaſure mentioned by him, *viz.* one diameter and $\frac{1}{18}$, to relate to all columns above that height. As it appears from ſeveral circumſtances that Vitruvius had ſtudied and drawn many of his rules from ancient Greek buildings remaining in his time; ſo in this inſtance it is not improbable that he may have had in remembrance the aforeſaid temple, the delineation of which may be ſeen in the firſt volume of Mr. Stuart's Athenian Antiquities.

BOOK III. Ch. III. Note (17). To the arguments on the ſcamilli impares I can now add the ſupport of ſeveral antient examples. When I wrote that note, I had not met with any inſtance in which the ſmall fillets that I ſuppoſed to be the ſcamilli were uſed in the baſes of columns, except in the Sybil's Temple at Tivoli. Since then, I have ſeen ſeveral repreſentations of antient buildings in which they were applied as in the Temple of Bacchus at Teos, and Temple of Minerva at Priene, repreſented in the Ionian Antiquities, both of

which have ſuch fillets in the baſes of their columns: they are not under the baſes; becauſe the Greeks made the joints of the ſtones in different parts, and frequently made the baſe, or part of the baſe, of one piece with the ſtep on which it ſtood (as in the firſt of theſe examples); but they are in both caſes at that part of the baſe where the joints have been made, ſo that they are equally well ſituated to anſwer the purpoſe of ſcamilli as if they were under the whole baſe. In the Parthenon, and Temple of Theſeus, at Athens, and in ſome other Doric temples, they are uſed at that part where the capital is ſet on the ſhaft of the column; for the ſmall fiſſure there obſerved appears to be for that purpoſe only. Another example is, the Temple of Pola in Iſtria, in which theſe fillets or ſcamilli are found both under the baſes and over the capitals of the columns, exactly as Vitruvius mentions. Theſe fillets have not been ſeen by Palladio, Le Roi, and others, who had meaſured this temple: and it is owing to Mr. Stuart, and Revett's accurate delineations (not yet publiſhed), that I am enabled to produce this example. The ſcamilli are alſo uſed in the antient arch yet ſtanding at the ſame place. Over the capitals they are to be ſeen in many antient remains; as, in the Ionic temple on the Iliſſus at Athens; the Portico of Octavia, called by Deſgodetz the Portico of Severus, at Rome; the Temple of Antoninus and Fauſtina; the Forum of Nerva; the Arch of Titus; the Thermæ of Dioclefian; and in the remains of the Temple of Jupiter Tonans. In this latter there appears a double ſcamillus, one above the other; the upper one is of white marble, and is let into a cavity made in the lower one. So that it appears very probable they were uſed for the purpoſes I have conjectured, that of raiſing the epiſtylium to a level, where the columns have varied a little in their height; as well as to prevent rupturing the edges of the capitals, &c.

BOOK IV. Ch. II. Note (1). In this note I argued the *tranſtra* to be the principal rafters of a roof; but I have ſince met with a paſſage at book x. ch. xxi. where the term is applied to the horizontal timbers of a floor—*ita ſupra tranſtrorum planitiem:* however, at book ii. ch. i. it is evidently uſed for the rafters, or the inclined timbers riſing from the four corners of a building, and meeting in a point in the middle of the roof—*item tecta recidentes ad extremos angulos tranſtra, gradatim contrahentes.* Hence it appears that Vitruvius uſes the term in both ſenſes; and perhaps it may be applicable to all timbers laid tranſverſely over a void, whether horizontally or inclined. The rowers benches, that croſſed the ſhip from one ſide to the other, were diſtinguiſhed by the ſame term.

BOOK IV. Ch. III. Perrault has altered the text, on a ſuppoſition that it is erroneous in that place of this chapter, where Vitruvius preſcribes the breadth of the Doric capital to be two modules and a ſixth part; a proportion that he, following Barbaro, thinks too ſmall to be endured: it has however the authority of a very antient example now ſubſiſting, *viz.* the Doric Portico at Athens; in which the breadth of the *abacus* of the capital is rather leſs than two modules and a ſixth, according to the meaſures given thereof in Mr. Stuart's Antiquities of Athens, vol. i.

BOOK IV. Ch. VI. The antient door of the Pantheon at Rome, according to Deſgodetz, appears to have been framed in the manner Vitruvius deſcribes, and exemplifies his text very exactly. For of the two middlemoſt impages, or horizontal rails, of this door, the upper one was at three fifths of the height, and the other at the middle of that height, agreeing therein with the directions of Vitruvius. I have therefore now altered *Fig. XXXI.* accordingly.

There are ſeveral examples of antient doors to be ſeen on marble ſarcophagi, which are framed in pannels. One is repreſented in Piraneſi's Antiquities of Rome, vol. iii. pl. 27: another is in the collection at Wilton, on a ſarcophagus which ſtands in the great hall. In both theſe examples one leaf of the door is repreſented opening outward, in which manner it is ſaid the doors of the antient Greeks uſually opened. See Plutarch in the Life of Poplicola.